THE

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J. A. BERLY'S

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BLOCK SIGNALLING.

IT is both interesting and curious to notice how divergent are the ideas associated with this subject on this side of the water, and on the part of our friends in the United States. Here, in England, we have ever sought to individualise the responsibility—to cut up our lines into what is termed "block sections," and to place the movement and control of the traffic therein in the hands of men located at either end. In America, the effort has always been to operate the signals governing the traffic by some automatic means. It is not a new idea with them. For years it has been the aim to establish some such system, and many such methods have been produced and employed. If, however, we are to judge by the fact that new systems are continually being brought forward, it would appear that whatever success may have attended previous efforts, the results are still such as to leave something to be yet accomplished—perfect confidence in the apparatus used has not yet been attained.

One of the latest methods proposed is that of the Union Switch and Signal Company, said to have been extensively adopted on American roads, especially in yards and at other points where considerable complication of switches is necessary. In this system the switches—what we term "points"—and the signals are actuated by compressed air, the air valves being operated by electric circuits controlled from a "signal house." This system is in use in the Pennsylvania Company's yard in Jersey City. Here, in a signal house, one man alone watches and operates the entire complication of points and signals in the section allotted to him. He is provided with a miniature map or model of the tracks or lines controlled, together with a series of electric switches, so arranged that the throwing of any one of them shifts at the same moment a switch in the yard and one in his model. Thus he has before him not merely a model of the yard and its signals, points, &c., but also a *fac simile* of all that he does—provided, of course, that all works well. When it is desired to operate a point, the commutator or switch in the signal house is turned; this first unlocks the gear at the crossing point and completes the electrical circuit with the magnet at that end of the cylinder which is required to move the points in the opposite direction. This done, the air valve is opened and the points pneumatically moved over into the required position, and there locked. A number of ingenious details are provided to additionally safeguard the operation of the different parts. Thus there is an automatic device for signals, so arranged, as to hold the appropriate switch or point in the station until the signal has taken up its proper position—all accomplished by certain contacts and connections attached to the signal instrument, and closed by a piston in its movement.

The automatic signalling is effected by insulating a section of the metals, and forming of it a part of a circuit

passing through a relay which operates a circuit controlling the signal mechanism. Normally, the current is active through this relay; but when a train is on the track thus insulated, and forming part of the relay circuit, the relay is short-circuited, and the signal automatically set at danger. The system throughout is to hold the signals normally at "clear," but any failure of the batteries, wires, &c., admits of the signals going to the danger position.

No one can fail to recognise the vast amount of ingenuity and ability displayed in the development of such a system as that at which we have thus cursorily glanced. Apparently everything has been well thought out, and provision made against every possible contingency. Normally, the line is kept clear, but the signals, under failure of any part of the operating gear, fall to danger. The principle is right that any derangement should place the signals in that position which will bring the trains to a stand—delay is always preferable to danger—but whether it is equally correct to keep the line signals normally clear is a very debatable point. Here, in England, most railways have arrived at the conclusion that it is better to keep the signals at danger, and to lower them for trains as asked for. It is probable that few countries, if any, have greater experience of railway working than England, and whether signals should be worked automatically or by any other means, it may be worth while taking into consideration the experience of the home country with regard to their normal position.

That automatic signalling presents certain advantages, from an economical point of view, will readily be admitted. That it is less reliable than human responsibility would appear, from results, to be the view held by English railway companies; but in this view, clearly, we are not supported by the exigencies or the experience of railway working in America. There, if we may judge from results, automatic apparatus is regarded as more reliable than human agency. We question much if this is the result of experience of railway work such as has to be contended with in England and on some parts of the Continent of Europe.

When American roads become as crowded with trains, and when the State is called upon to exercise the same watchful influence over their arrangements for the protection of the travelling public as is done by the Board of Trade in England, we shall be deceived if individual responsibility is not more fully recognised and called into existence than is the case at present. Excellent as may be, and no doubt are, the devices at present employed, certain complications are unavoidable. When first brought into use such apparatus may, and probably will for some time, work well, but in time difficulties will arise, and those very ingenious devices, which all must admire as a work of art, will prove most troublesome to keep clear of complications. In fact, a large railway yard with its numerous points and signals to be operated as here shown, would require an electrician always in attendance, in order to remove rapidly any derangement which might arise; and even then, one of two things must happen—the working of the trains must be conducted by hand, by men on the ground, or the traffic must be kept standing till the defect has been adjusted.

In saying this, we hope it will not be thought we are entirely averse to the employment of automatic apparatus in connection with railway working. This is not so; we are of opinion that properly combined with apparatus for which there exists individual responsibility, it is a very desirable thing. Where a man is in a signal box we would leave him to work by his own hands such signals and points as he is able to do, rather than operate them by intermediate means, such as pneumatic or electrical power. We believe that such a course would be attended with less failures and less inconvenience to the traffic. But we would enforce the automatic connection or combination of the electric block signals with the signals which govern the movement of the trains. In all probability at the moment we are writing, in conformity with the recent Railway Regulation Act, every line of railway in England, Scotland and Ireland, traversed by more than one engine, is worked upon the block system. It is a great step towards the security of railway travelling, but all who know anything of railway working, of human fallibility, will be with us when we say that until the electrical block signals are so connected with the mechanical signals as to render their action uniform and synonomous, we shall not have arrived at that stage of security which it is within our power to command. Now, we depend upon the careful conduct of signalmen—an exemplary class of men, of whom we cannot speak too highly. They have to observe the signals of their electrical instruments, and work their signal and point levers accordingly. These electrical signals should be so arranged as to interlock with the key lever of the signals controlled by the electric signal.

There are other points where automatic signalling may with advantage be applied, and we hope to return to the subject again ere long. At present, our remarks have gone somewhat beyond what we had contemplated, and space forbids our dwelling longer upon the question. We feel that railway traffic can be most safely conducted only where individual responsibility exists, and that can only fully exist where the movement of every train is regulated by the individual action of a responsible agent appointed to the duty; but we feel, also, that this responsibility may be greatly lightened, and security greatly strengthened by automatic combinations, governed by such individual responsibility.

CENTRAL STATION SYSTEMS.

THE last issue of our esteemed contemporary, *Industries*, contains a most suggestive leader on "Electrical Sub-stations," in which, however, many points in connection with central station work are dealt with besides those relating to sub-stations. Our contemporary is of the opinion that central station design is very largely controlled by fashion, and not always to the benefit of the industry; and it therefore suggests various departures from existing practice, which it presses on the consideration of engineers engaged on the design of central station systems. Foremost amongst these is the improving of the coal consumption per unit delivered, which, by reason of the low load factors is abnormally high, by substituting gas engines for steam engines; a change which would result, if water gas were used, in reducing the coal consumption to about 1½ lb. to 2 lbs. per *required* horse-power. This estimate of the coal consumption is probably rather too favourable, whilst that given in comparison with

it for steam engines, viz., 10 lbs. to 30 lbs., is too high, being much in excess of what has already been attained in existing stations; but we believe that in may cases a substantial saving might be effected in the cost both of fuel and of labour by the use of gas engines, and that if the makers are prepared to supply them of sufficient power, and can overcome the difficulties of noise and vibration, which are so frequently the cause of trouble in private installations, we shall see in the course of a few years stations using gas instead of steam for the prime motors.

Another matter which is referred to as an example of the rule of fashion, is the tacit assumption on all sides that alternating currents and high pressure must necessarily go together, and equally direct currents and low pressure; whereas there is every reason to expect a considerable improvement in the efficiency of distribution by the alternating current, if it is supplied at low pressure in the neighbourhood of the station, and high pressure with transformers is used only for the more distant portions of the district. No mention is made by our contemporary of troubles likely to arise with the use for alternating currents of conductors of large sectional area, though this is a matter which must be taken into consideration, and must modify to some extent the method of arranging the low pressure mains; but this difficulty, once recognised, is not a very serious one, and has equally to be met by the users of transformer sub-stations supplying an extended low pressure network. Of the advantages of these transformer sub-stations, the article we refer to has not a very favourable opinion, advocating rather the use of single transformers at the end of each feeder, on the grounds that large transformers can be designed to have a good all-day efficiency, and that automatic switches for cutting in and out the transformers in a sub-station are therefore unnecessary, and further, are likely to lead to breakdowns and failures.

The City & South London Electric Railway.

DR. E. HOPKINSON has advisedly given way to the continued friendly hints of ourselves and other well wishers of electric railway work, and now publishes a few details with reference to the running of the City and South London line. The reticence of the railway authorities has served no useful purpose, but, on the contrary, has given rise to probably undeserved criticism, and several erroneous statements. We are glad to find that the cost of traction, 5½d. per train mile, is so low. This is 25 per cent. less than the figure guaranteed by Messrs. Mather and Platt for the particular mileage, although the net weight of the trains has been increased 40 per cent. above that given to the electrical engineers in the first place. There is reason for congratulation all round, and we may look for a rapid extension of the underground electric railway system. The next line, however, we believe, will be built with a 12 feet diameter tunnel, large enough to run main line coaches, so as to save passengers the necessity for changing when crossing from the north to the south of London, &c. From the data to hand there are some grounds on which to compare steam and electric traction. It does not seem probable that electricity will supersede steam, but undoubtedly it will develop a field for itself, and in many cases will overlap parts of the system now run entirely by steam locomotives. Judging from the Southwark experience, the electric loco is capable of a yearly mileage as great, if not greater, than that of the steam engine under similar conditions. Dr. E. Hopkinson says the yearly average for the Metropolitan District locomotives is less than 20,000 miles; while on the electric railway the average made by 13 locomotives was more than 27,000 miles. This is most satisfactory, and proves what we have always contended, viz., that the electric motor is far less likely to get out of order than engines having reciprocating parts. For underground railways electricity must inevitably supersede steam, and before long the "Inner Circle" will be so equipped. The new gearless motor seems to have solved the difficulty of construction, and there is no reason why the size should not be increased to meet the output of some 600 to 700 H.P. required. There are several American companies that have already built motors of from 200 to 500 H.P. on these lines, and more than one English firm would be ready to do the same and guarantee the work. We may look for some big things in electric railway work before long.

The Cuttriss Carbon Relay.

THE relay for submarine cables, designed by Mr. Charles Cuttriss, and described in our last number, is most ingenious, and we venture to predict for it a wide use. The present system of manual re-transmission has long been set down as clumsy, expensive, and inaccurate, for it is at intermediate stations that errors in receiving and sending are most likely to creep in, but the many difficulties in the way of mechanical re-transmission have forced telegraphists to the continued use of the old system, with all its faults, and in all its clumsiness. It is easy enough to design, on paper, a perfect relay for recorder work, a couple of contact points fastened to the recorder coil, and a corresponding set of fixed contacts on the frame of the instrument constitute all that is required—theoretically. When we remember, however, the minuteness of the currents with which we have to work, and the consequent delicacy of the apparatus, we begin to appreciate how small are the forces which we have at command to press the contacts home. Although the steady current may be but a small fraction of an ampère, there will be, at starting, a small insidious arc, which will weld together the contact points of our ideal relay in a most provoking and aggravating manner. This sparking, it is true, can be reduced by a judicious shunt or a subtle condenser, but experience shows that these do not entirely eliminate "stixion" at the contact surfaces. Nor is stixion the only grievance, for even supposing it were overcome, there remain all the difficulties of a shifting zero, an earth current, or a variation in the fibres or siphon necessitates a new adjustment of affairs all round, and this by an impatient and perhaps incompetent manipulator. The device of using a change of resistance in the relay circuit instead of an abrupt break, and the combination with it of a differential system for magnifying this change is the essential principle of the invention of Mr. Cuttriss. His article does not state the actual resistance of the carbon springs, nor the change in the resistance which results from an extension of the springs when the recorder coil actuates them; we should be glad to know what values are practically used. Although this relay would seem to require very careful adjustment when first installed, there does not appear to be much that can get out of order when it is once under way. There is an increasing demand for a good cable relay, and this device of Mr. Cuttriss comes as near to a workable instrument as anything we have yet had described.

The Starting of Electrical Tramcars.

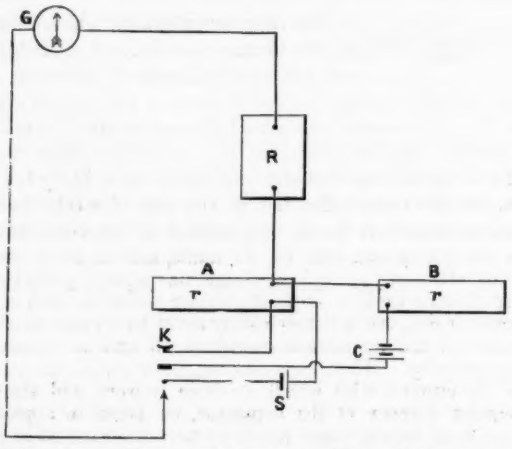
MR. DOLBY writes to the *Engineer* for June 3rd, advocating friction gearing instead of resistances for use in starting electrical tramcars. He is mistaken in supposing that less power would be consumed by the device he recommends than in the resistance coils. As a matter of fact the power required to start any tramcar in a *given time* at a *stated velocity* is a *definite quantity*, and practically independent of the method of supplying power to the rolling axle. Whether energy be wasted in heating the friction clutch or the resistance is immaterial, a *definite torque* is required to do the work in the given time, and the corresponding current must be supplied. From various reasons friction devices for tramcars have always failed, while resistance frames are cheap, handy and reliable. Mr. Dolby instances electrical cranes as examples of successful applications of friction gear. The functions of the crane and the tramcar are so different that the analogy will not hold good.

PRELIMINARY NOTE ON SOME TESTS OF THE CARHART-CLARK STANDARD CELLS.

BY PERCY MATTHEWS AND JAMES E. HEWES,
Johns Hopkins University.

THE following tests were made to determine the relative variation of E.M.F. between individual cells and of the E.M.F. of a given cell with temperature. Six cells were sent to us directly by Prof. H. S. Carhart, precisely the same as those supplied by him to Messrs. Queen & Co. They were received on February 14th, and first tested March 12th.

The arrangements for the test are shown by the following diagram.



G, High resistance Thomson galvanometer; R, High resistance; K, Double successive contact key; C, Two Gonda cells; S, Standard cell; r, 11,000 ohms.

These will be seen to be the same as in the method used by Lord Rayleigh and Mrs. Sidgwick in their test of the Clark standard cells. The total resistance used in the two boxes, A and B, was 20,000 ohms. The ohms in A required to balance a cell are obviously proportional to its E.M.F.

The following are the results of our first test, Table I. :—

TABLE I.

No. of cell.	Temperature of cell in deg. C.	Ohms in A to balance.	Ohms in A to balance at 15° C.
227	22·3	10,666	10,696
228	23·8	10,660	10,697
229	23·2	10,664	10,698
230	23·2	10,664	10,698
231	24·2	10,662	10,700
232	22·9	10,663	10,696

The ohms to balance at 15° C. are deduced by means of the formula given by Prof. Carhart, viz. :

$$E_t = E_{15°}\,[1 - \cdot00039\,(t° - 15°)].$$

The cells were next immersed in a water bath in order to compare the E.M.F. more nearly independent of temperature. The following results were obtained in this way, Table II. :—

TABLE II.

No. of cell.	Temperature of cell in deg. C.	Ohms in A to balance.	Ohms in A to balance at 15° C.
227	13·2	10,647	10,640
228	13·3	10,644	10,637
229	13·2	10,646	10,638
230	13·2	10,643	10,636
231	13·1	10,646	10,639
232	13·2	10,644	10,637

Cell No. 230, which, it will be seen, has the lowest E.M.F., had two days previously been placed on a short circuit of 15,000 ohms. On account of the proximity of the water and the very high internal resistance of these cells, it is possible that the terminal P.D. was reduced, due to leakage, by something of the order of 1 in 10,000.

From these tests, therefore, all that can be fairly concluded is that the variation of the six cells between themselves is not greater than 4 in 10,000, and that from the mean the variation is not greater than 2 in 10,000.

The cells were then tested for the accuracy of the temperature coefficient given by Prof. Carhart in the following way: Cell No. 229 was immersed in a water bath with a thermometer alongside of it, and balanced at different temperatures. The temperature of the water was varied and the water stirred. In order to check the "Gonda" cells for any change in their E.M.F. during the time of the experiment, a Carhart-Clark cell, set up in its brass case with a thermometer in the hole provided for that purpose, was balanced against the Gonda cells.

TABLE III.

Ohms to balance cell at const. temp. at 15° C.	Temperature of cell under test in deg. C.	Corrected ohms to balance cell under test. Observed.	Ohms to balance from coefficient ·00039. Calculated.	Difference in parts in 10,000.	
10,582	11·6	10,613	10,615	2	Cell No. 229.
10,580	15·2	10,600	10,600	0	
10,581	19·1	10,584	10,584	0	
10,580	24·2	10,562	10,563	1	
10,579	28·2	10,546	10,546	0	
10,578	37·6	10,509	10,507	2	
10,575	29·6	10,543	10,541	2	
10,575	24·6	10,562	10,561	1	
10,575	20·0	10,582	10,580	2	
10,572	14·9	10,603	10,601	2	
10,571	9·5	10,625	10,624	1	
10,573	7·7	10,628	10,631	3	
10,600	10·7	10,612	10,612	0	Cell No. 228.
10,600	20·6	10,575	10,571	4	
10,600	24·2	10,557	10,556	1	
10,599	30·7	10,526	10,529	3	
10,598	40·1	10,491	10,491	0	
10,608	50·8	10,449	10,445	4	
10,599	41·6	10,479	10,484	5	
10,598	31·4	10,525	10,526	1	
10,598	25·2	10,552	10,552	0	
10,598	14·8	10,591	10,595	4	
10,598	4·4	10,638	10,638	0	

In Table III. the column to the left indicates the change in E.M.F. of the Gonda-Leclanché cells, for which the ohms to balance in the next column but one are corrected. This cell was not one of the lot sent to be tested.

The first set of the above readings was taken on cell No. 229; the second on cell No. 228. We place more reliance on the first test, as the temperature was varied more slowly. The only difference in the arrangements for the two tests was that in the second case the cell used to check the Gonda cells was immersed in another water bath with a thermometer. The temperature of this cell varied 2° C. in six hours. —*New York Electrical Engineer.*

THE SUPPLY OF WATER, LIGHT, AND MOTIVE POWER AT LYONS.

OF several schemes that have recently been proposed for the distribution from a central station of motive power in the town of Lyons, one, of which M. Verny is the author, is of a most ambitious character, and aims at combining in one undertaking with the supply of motive power that also of water and of light. The requirements of the town at the present time are stated by M. Dieudouné, in an article in our contemporary, *L'Electricien*, to amount to from 30,000 to 50,000 cubic metres of water daily, according to the season, and to about 13,000 horse-power for industrial purposes, whilst in the matter of lighting the gas company is called on to supply about 130,000 lights; the total expenditure on these three necessaries amounting to 13 or 14 million francs per annum.

M. Verny proposes to substitute electric light for gas, and electric motors for the steam and gas motors at present used for pumping the water into the town reservoirs, and for

industrial purposes in the factories of the town; and to generate the current required for these various purposes, he proposes to use the energy of certain waterfalls of the Alps, distant nearly 200 kilometres from Lyons. The plant is to consist of 14 turbines, each coupled direct to a multiphase dynamo of 2,500 H.P., the total output exclusive of reserve being 30,000 H.P. The current supplied by these dynamos will be transformed up to a pressure of 40,000 volts, and transmitted by aerial lines to six receiving stations on the outskirts of the town; it will then be transformed down to a pressure suitable for the distribution to the consumer's premises, where it will be again transformed down to the pressure required by the receiving apparatus.

Of the 30,000 H.P. generated, 20,000 will be available for distribution at Lyons, of which half is to be used to furnish current for 100,000 incandescent lamps, whilst the other half is to be appropriated to the supply of motive power for industrial purposes. As the demand for this latter will be almost entirely during the daytime, it is proposed to utilise a portion of the 10,000 H.P. available at night, to operate the pumps in connection with the water service. The cost of establishing the plant is estimated at 37,864,000 francs, and the annual working expenses, including a fund for paying off the capital in 20 years, are put down at 4,880,000 francs; whilst the revenue is estimated at 10,400,000 francs, obtained by charging 400 francs per annum per horse-power used during the daytime, and 200 francs per horse-power used during the night, 25 francs per metre cube of water per annum, and 1·08 francs per kilowatt hour for lighting.

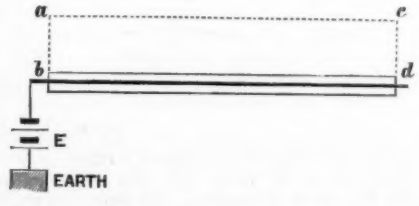
The very handsome balance of over 5,000,000 francs, exhibited on paper, has quite a tempting appearance, but a capital expenditure of about one and a half million pounds sterling is rather a big undertaking, when the system of transmission on which it is to be spent is altogether an untried one. The very interesting experiments shown by Messrs. Siemens and Swinburne have proved conclusively that, with pressures such as 40,000 volts, backed up by plenty of horse-power, all our ideas concerning insulation must be considerably modified; and although we are not so rash as to prophesy that such schemes as the one we have noticed will never be commercially successful, we certainly hold that the time has not yet arrived, as notwithstanding the experiments at Frankfort, we are only at present struggling with the veriest A B C of the problem of extra high pressure transmission.

THE INDUCTIVE CAPACITY OF LOOPED CABLES.

By H. R. KEMPE.

It is well known that the "K R" of a loop formed of two cables, no earth being used, is the same as the "K R" of one

Fig 1.



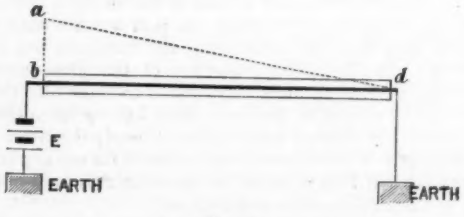


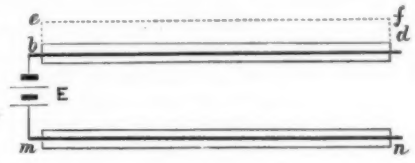
Fig. 2.

of the cables with the ends put to earth, but the proof of this has so often been asked for, that the following general investigation may be of use in explaining the law:—

If b, d (fig. 1) be a cable, whose further end, d, is insulated, and whose nearer end is connected to a battery, E, as shown, then if a b represent the electromotive force of the battery, the charge in the cable will be represented by the area, a, b, d, c, which we will call "4."

If now the further end, d, of the cable be put to earth, as shown by fig. 2, then (assuming the battery to be of negligible resistance) the charge taken by the cable will be represented by the area of the triangle, a, b, d, which will be equal to "2."

Fig. 3.



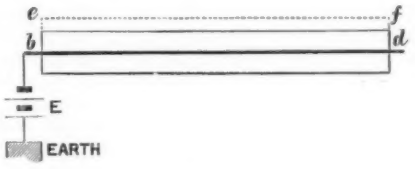
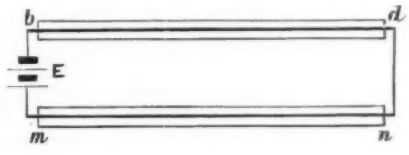


Fig. 4.

If instead of connecting the second pole of the battery to earth as in fig. 1, we connect it to a second cable as in fig. 3, then it must be evident that this is equivalent to the conditions shown by fig. 4, in which b, d, is a cable, with such an extra thickness of covering, that it has half the capacity of that in the case of fig. 1. In other words, fig. 3 represents the case of two capacities joined up in "cascade" The charge held in the case of fig. 3, *i.e.*, in the case of fig. 4, will be represented by the area, e, b, d, f, which is half the area of a, b, d, c of fig. 1, that is to say, the charge would be equal

Fig. 5.



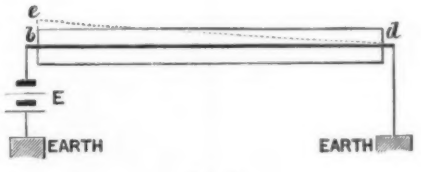


Fig. 6.

to "2" Take now the case shown by fig. 5 where we have the ends, d, n, of the cable joined together. In this case we have a condition of affairs equivalent to that shown by fig. 6, that is to say, the charge held is that represented by the area, e, b, d, which is equal to "1."

Fig. 5, then, represents the case of two cables looped together so as to form a "metallic circuit," and the charge held in this case is equal to "1," that is to say, "1" represents the "effective capacity" of the arrangement. Fig. 2 represents the case of a single cable with earth used at both ends, and in which the charge held, or the effective capacity, is equal to "2." But in the case of fig. 5 the conductor resistance of the two cables is twice that of the single cable, fig. 2, hence the "K R's" of the two cases are—

$$1 \times 2 = 2, \text{ and } 2 \times 1 = 2$$

2 and 1 representing the conductor resistances. So that the

"K R's" in both cases are the same. It may be added that if the length of cable in fig. 5 be stretched out in one length and be connected to the battery in the manner shown by fig. 1, then the charge held will, of course, be "8," or twice that in the case of fig. 1, since there is double the length of cable. Hence the charge held in this case will be eight times that in case fig. 5.

IMPROVEMENTS IN MIRROR GALVANOMETERS.

ALTHOUGH improvements have been made from time to time in the general construction of mirror galvanometers, it can hardly be said that perfection has yet been reached. We have recently had the opportunity of examining some mirror instruments constructed by the India-Rubber, Gutta-Percha and Telegraph Works Company at Silvertown, in which important and valuable improvements have been made which are well deserving of notice. The illustrations show the construction of the reflecting astatic galvanometers of the new pattern. The general view is of the particular type of instrument made for testing-rooms in factories and buildings shaken by machinery, and the others show the construction of the coils and of the astatic suspension. The galvanometer is of the usual modern pattern in a square case, having the coils carried on a central brass frame and mounted on an ebonite slab, only the whole is turned upside down, and instead of standing on three levelling screws, is hung by three long India-rubber tubes attached at the top to adjustable suspension pieces. By turning the nuts of these, the galvanometer can be levelled, a plumb bob for the purpose being attached to the side of the case. This arrangement is mechanically equivalent to that of a seismograph, which consists of a body freely supported in such a manner that its period of oscillation is very different from that of the vibrations likely to be imparted to the supports. With this galvanometer the periods of vertical oscillation due to the elasticity of the India-rubber, and of lateral oscillation in the manner of a pendulum are both very much longer than the period of vibration of an ordinarily stiff building. As a matter of fact the sight on the scales of the galvanometers at Silvertown are perfectly steady in rooms where it is impossible to use such an instrument standing on a table.

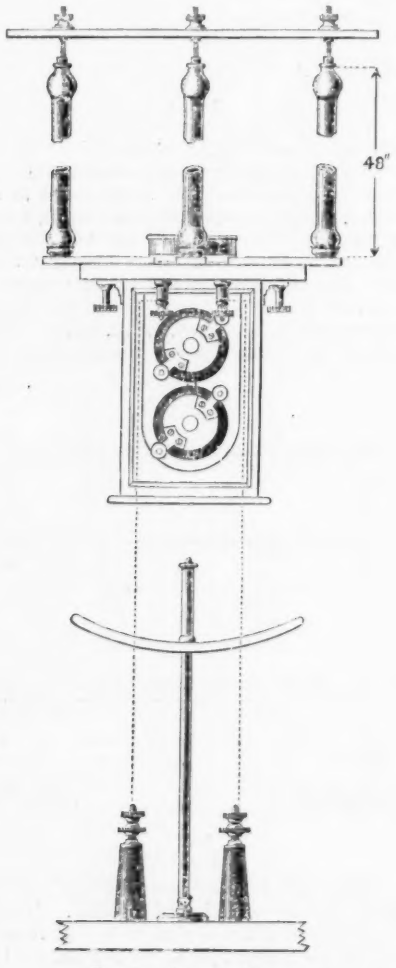


FIG. 1.—GENERAL VIEW.

The coils are attached to the frames in the manner shown in the second figure. The end of the coil wires are soldered

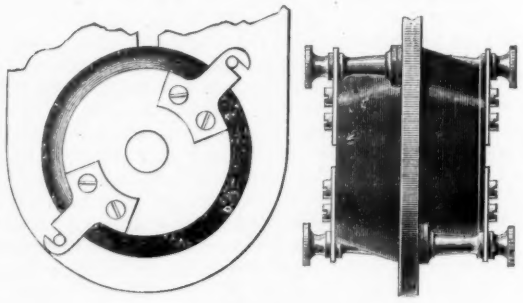


FIG. 2.

to plates fixed to the outside cheek, and these serve at once to fix the coil to the two insulated pillars on the frame, and to complete the connections of the instrument. It will be seen that by loosening the binding nuts and slightly turning the coil, the whole may be removed and access had to the suspension without risk of breaking any connection wires. All coils made for these instruments are interchangeable, and the galvanometer can be supplied with different sets of coils wound to high or low resistances.

The third drawing shows an exaggerated view of the

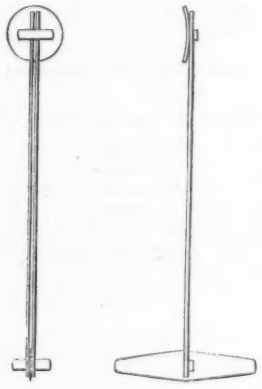


FIG. 3.

suspension. It is constructed of two very fine glass tubes laid side by side, to which are cemented magnets, mirror, and vane, the latter being of mica. By this construction it is easy to build the whole very square and true, and the weight can be reduced very nearly to that of the magnets and mirror. From the elasticity of the glass, the part is much more safely handled than those of aluminium, and it cannot get bent or distorted. In the drawing the size of the glass tubes and the space between them is exaggerated to show how they lie.

The small weight of the suspension and its large damping vane make the motion very slow and nearly deadbeat. The galvanometer is consequently not adapted for use as a ballistic instrument; if it is intended for use with this work a heavier form of suspension must be employed.

As to the figure of merit. Wound to a resistance of 7,000 ohms these galvanometers while perfectly controlled will, with $\frac{1}{1000}$th of a microampère, give a deflection of about one minute of arc—equal to a movement of the spot of light of one division on the scales commonly used with them—the

controlling magnet being then at the extreme top of the supporting rod in the case of the ordinary pattern which stands on a table. The length of the free fibre, it may be added, is about 2½ inches.

A DOUBLE TROLLEY ELECTRIC RAILWAY PROPOSED BY MONCKTON IN THE YEAR 1874.

By A. M. TANNER.

ANOTHER early inventor in the electric railway field is Edward Henry Cradock Monckton of Fineshade, Northamptonshire. In quite a voluminous British patent obtained by him on the 24th day of January, 1874, No. 265, for electro-magnetic engines, &c., is found the following description of an electric railway with two line conductors and double trolley, viz.: "I construct railways with insulated wires, by preference of copper, secured between the rails, along and against which either a single insulated metallic grooved wheel runs, or else these rods are clipped by pairs of similar wheels, which embrace their sides as the engine moves onward. The electricity generated from any source along the railway can thus be conveyed to the magnets actuating the engine. For this purpose, large fixed steam engines, wind and water power, may be employed, and the electric currents so generated be conveyed to and along these rods, which are protected above from the rain by covers secured to supports, soldered to them. In underground railways this system would be very valuable, as by it smoke, carbonic acid gas, foul air, and noise would be avoided. At crossings the rods would be carried underground as far as possible, when they would again be brought to the surface, and be again embraced as before by the clip wheels, the impetus of the train carrying them over the interval.

"Where many trains run in a day, and this system is mainly relied upon as a motive power, stations and apparatus for generating the electric current should be multiplied in proportion, thus each train having passed over a certain distance or division of these conducting rods, and having reached a second division of them, the first division will be again ready for conveying the electric current to the next train. By means of this novel block system no second train can possibly run along the same line till the first has passed to the next division."

It is evident from the foregoing description that Monckton disclosed the basic features of the double trolley electric railway as early as the year 1874, and it is questionable whether a later American inventor can uphold the following claim found in patent No. 270,186 of the year 1883, viz.: "The combination of a machine or other source of electricity, conductors connected to the opposite poles of said source, and extending overhead along a road or course, a travelling electrical contact mounted on, and capable of travelling along, said conductors, having its opposite contacts insulated from each other; a vehicle, an electromotor mounted on said vehicle, and having power connection with the axle thereof, and branch conductors extending from the traveller to the poles of the motor."

It will be observed that Monckton makes no direct mention of placing the line conductors overhead, and hence British patent No. 265 of the year 1874 does not, on its face, meet the exact phraseology of the American patent claim above quoted.

In former articles, however, the writer drew attention to French, Austrian, and Belgian patents of Major Bessolo, granted in the year 1855, describing the circuit of an electric railway formed in part of an aerial insulated conductor, and the track rails. The omission in the Bessolo description of a travelling connection with the overhead conductor has raised doubts as to the precise arrangement contemplated by the Italian inventor. Although the writer is convinced, from original sketches personally submitted to him by Major Bessolo, that a top running trolley or sheave and a branch wire formed a travelling connection between the aerial conductor and the car motor, such proof will probably not prevail in any court requiring a published description as a statutory bar to the validity of a patent claim. History, however, will unquestionably recognise Bessolo as having first proposed an electric railway with an overhead conductor and the track rails forming part of the circuit.

It is a well known fact, established by numerous patents obtained in different countries, that so-called train telegraph systems have circuits and travelling contacts closely resembling corresponding parts of electric railways.

A British patent granted to Sir David L. Salomons, October 13, 1874, No. 3,515, strikingly illustrates how the trolley wires or line conductors of train telegraph systems could be placed in different positions relatively to the track. The drawing shows a "third rail conductor" between the track rails and a spring pressed trolley running thereon; the specification, however, states that "the signal rail (line conductor) need not necessarily be placed between the rails and under the train; at the *side of the rails, considerably above the ground, or overhead* would answer the purpose equally well."

It is quite likely that Monckton had the intention of arranging the line conductors between the rails and above the train, or car roofs. Such an assumption is warranted by the description of the covers for protecting the line conductors *above* from the rain. Had it been the intention to locate the conductors near to the ground some expedient would obviously have been described for protecting the conductors from ground moisture and snow.

The statement that the conductors were to be protected above from the rain by shields or covers appears to clearly indicate that no protection of the conductors was needed against anything coming from or existing beneath the conductors.

Is is, therefore, not a stretch of imagination to hold that the Monckton line conductors were arranged overhead. It certainly required no invention to arrange them in this way and Sir David Salomons has well indicated that conductors for conveying electric currents to travelling railway trains could be arranged beneath or above the train without any departure from the invention held in view.

REMARKABLE WATER POWERS.*

ALTOGETHER the most extraordinary water power installation—so far as head is concerned—ever known, has recently been made by the Pelton Water Wheel Company, in one of the famous Comstock mines, at Virginia City, Nevada. The wheel is 36 inches diameter, made of a solid steel disc, with the buckets riveted on to the periphery in a way to afford absolute security, weighing complete 180 pounds.

It is running under a vertical head of 2,100 feet, equal to 911 pounds pressure; 460 feet of this head is obtained from the pipe line of the Gold Hill Water Company, and the remaining 1,640 feet from the California and Con. Virginia shaft, down which the pipe line is run to the Sutro tunnel level, where the power station is located, and through which the water discharges after passing over the wheel. The wheel runs at 1,150 revolutions, with a peripheral speed of 10,804 feet per minute, or about 120 miles per hour.

The construction of the wheel amply provides for the centrifugal strain the velocity of the water gives it, running without load, when it would attain the enormous speed of 21,608 feet per minute, equal to about 240 miles per hour. A nozzle tip, ½ inch diameter, gives under above conditions 100 H.P. Every miner's inch of water, equal to a flow of 1·6 cubic feet per minute, gives 5 H.P., while 1 H.P. is given for every 2 lbs. of metal in the wheel. It is only by comparison that an idea can be obtained of the height of a column of water due to such pressure. It is more than four times as high as the Washington monument, and considerably more than twice the height of the Eiffel tower. It is safe to say that no water wheel has ever before been operated under any such head, nor any such demonstration afforded of the velocity and power of water under such an extreme pressure.

The installation made by the Pelton Company some two years ago in the Chollar shaft on the Comstock lode is in some respects no less extraordinary. This consisted of six

* *Scientific American.*

40-inch Pelton wheels, which run under a vertical head of 1,680 feet, driving that number of electrical generators, the power from which is conveyed up the shaft to the Nevada mill, some 2,000 feet distant. These wheels only weigh 220 lbs. each, and with nozzle tips $\frac{5}{8}$ths of an inch diameter, develop 125 H.P. each.

The water is first run over a Pelton wheel on the surface under 460 feet head, and is then carried down the shaft by a pipe to the Sutro tunnel level, where the underground station is located, the power from the electrical generators being conveyed to the countershaft of the mill with which the surface wheel is connected, the two distinct forces working together in perfect harmony.

A most interesting illustration of the double use of water is here given, some 400 H.P. being produced in this way from what may be termed waste water. This station has now been running more than three years without interruption, and practically without expense in the way of repairs, as well as without any appreciable loss of efficiency, affording a most striking example of the advantages of water power, both by direct application and electric transmission, as well as the reliability of such a plant under such extraordinary conditions.

RESEARCHES ON POTENTIAL DIFFERENCES AT THE SURFACE OF CONTACT OF DILUTE SOLUTIONS.

SINCE the ions of an electrolyte are endowed with large electrostatic charges, it follows that before the electromotive forces become active a certain finite determinable amount of free electricity must be formed in the solution. By reasoning in this way, M. Planck was enabled to calculate the forces necessary to cause a movement of electricity in an electrolyte, starting with the assumption that in an electrolyte the ions are present in a fully dissociated condition (*vide Ann. Phys. Chem.* [2], xxxix. pp. 161—186). In this paper the author calculated the difference of potential for the case of two solutions containing the same electrolyte in different proportions.

A further paper upon this subject was contributed (*vide Ann. Phys. Chem.* [2], xl. pp., 561—576), by Planck, in which the integration of the differential equations for the general case of two solutions containing different electrolytes was considered. The existence between the two solutions of a limiting layer of small but still finite thickness was assumed and different values for the difference of potential were found according to the way in which the concentration is supposed to alter within the intermediate layer. It was shown, however, that in a very short time a state of stability is reached in which the total concentration (*i.e.*, the sum of the concentrations of the positive or negative ions), varies within the layer as a linear function of the distance. This consideration is sufficient to make the problem uniquely soluble, supposing the electrolytes to be completely dissociated. The paper also contained a comparison of the calculated values for the difference of potential with Nernst's experimental numbers; this showed a satisfactory agreement.

This subject has more recently been attacked by W. Negbaur, who has directed his attention to the potential differences at the surfaces of contact of very dilute solutions. He contributes a paper to the *Ann. Phys. Chem.* (*vide* [2], xliv., pp. 737—758.), the main object of which is to show that experimental evidence supports Planck's theoretical work.

The observed values of the difference of potential between two dilute solutions of electrolytes agree generally with those calculated by means of Planck's formula. In solutions of equivalent or nearly equivalent strength, the direction of the current is always determined by the ion which has the greater velocity of the two unlike ions, this always moving with the positive current. The evidence obtained from experiments with concentrated solutions was not so confirmatory.

Negbaur's work, however, was not to pass unchallenged in the *Annalen* (*vide Ann. Phys. Chem.* [2], xlv., pp. 360—369). W. Nernst has a paper which consists for the most part of critical observations on these experimental results of Negbaur. The author further states that the osmotic pressure of dilute salt solutions calculated by means of his theory from the electromotive activity of the ions, agrees within one or two per cent. with the osmotic pressure as devised from the theories of Van't Hoff and Arrhenius. He argues that the measurement of electromotive forces is thus, for dilute solutions at least, by far the most exact method of indirectly measuring osmotic pressure.

BRAKES.

BY E. T. CARTER.

BRAKES are contrivances attached to vehicles or moving machinery for the purpose of absorbing surplus energy. In the case of a vehicle, such as a tramcar, there are two conditions under which energy must be absorbed: first, when the vehicle is descending a steep gradient at a steady rate; second, when it has to be brought to rest either on a gradient or on the level. It is obvious that the energy absorbed per second in the latter case will exceed that absorbed in the former, so that it will suffice if the brake is designed to be strong enough to bring the car to rest within a given distance. As the car will sometimes have to stop on a down gradient, it is evident that the maximum work the brake will have to do will occur when it stops the car on the steepest gradient on the track. This case only, therefore, need be considered.

The energy absorbed in bringing a car to rest from any given speed downhill is derived from two sources: (1) The kinetic energy of the car; (2) the work done by the car on account of its vertical descent during the time the brake is in action.

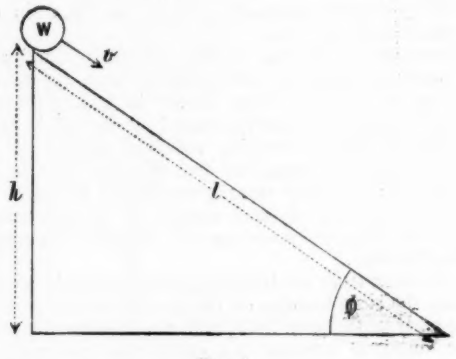


FIG. 1.

In fig. 1 let l represent the distance along the track in feet in which the car is brought to rest, and h the vertical fall in that distance owing to the track having a gradient, ϕ. Let v be the velocity of the car in miles an hour, and W the weight of the car in tons. Then the energy absorbed in stopping the car, in foot pounds, will be—

$$E = 75{\cdot}6\ W \cdot v^2 + 2{,}240 \cdot W \cdot h,$$

and

$$h = l \cdot \sin \phi,$$

$$E = 75{\cdot}6\ W \cdot v^2 + 2{,}240\ W \cdot l \cdot \sin \phi.$$

In most brakes this surplus energy is absorbed by friction, by means of blocks of wood or cast iron pressed against the rim of one or more wheel. The energy is then wasted, developing heat and wearing away the brake blocks. Let F be the force of friction in pounds due to all the brake blocks on the car or train, then the work done against friction is—

$$E = F \cdot l \text{ foot-pounds},$$

whence

$$F \cdot l = 75{\cdot}6\ W\ v^2 + 2{,}240 \cdot W \cdot l \cdot \sin \phi,$$

and

$$F = \frac{75{\cdot}6\ W\ v^2}{l} + 2{,}240 \cdot W \cdot \sin \phi.$$

It is usual to proportion the distance l, to the square of the velocity of the car at which the brake comes into action as follows:—

$$l = 0{\cdot}6\ v^2 \text{ for tramcars,}$$
$$l = 0{\cdot}4\ v^2 \text{ for railway trains.}$$

Whence

$$F = 126{\cdot}0\ W + 2{,}240\ .\ w\ .\ \sin\phi\ .\ \text{(tramcars)},$$
$$F = 187{\cdot}5\ W + 2{,}240\ .\ w\ .\ \sin\phi\ .\ \text{(railway trains)}.$$

This amount of force at the wheels of the vehicle must be obtained by the provision of a suitable amount of brake block bearing surface, and by means of a brake-applying gear capable of exerting a certain pressure between the blocks and the rim of the wheel. In fig. 2, let F be the

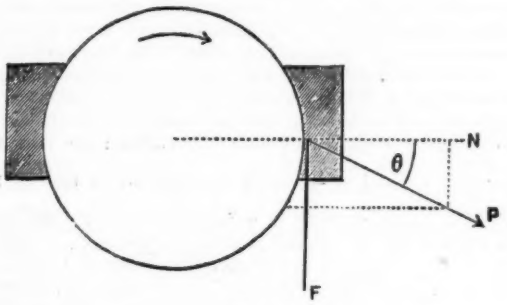


FIG. 2.

friction acting tangentially to the wheel, and N the pressure normal to the rim. Then

$$N = \frac{F}{\mu},$$

where μ is the coefficient of friction for the materials of the block and rim. The two forces, F and N, are compounded into a resultant thrust along the line P, at an angle θ with the radius of the wheel; where θ is the angle of friction, and

$$\tan\theta = \mu.$$

Consequently, in order that the thrust, P, may not twist the block on one side, the force exerted by the brake rod must be in the line of P, equal and opposite to it. The brake rod should not apply a force to the blocks quite at right angles to the rim of the wheel, but should be tilted forward in the direction of motion of the wheel by an amount equal to the angle θ. The amount of the force which this rod must exert is determined as follows :—

$$P = \frac{N}{\cos\theta} = \frac{F}{\sin\theta}.$$

The normal pressure on the block must not be concentrated on a very small amount of surface, or the brake will get too hot and excessive wearing will occur. Moreover, the crushing strength of the material of the block being low, and a high factor of safety being necessary, it is impracticable to have a pressure exceeding 30 lbs. per square inch except for very strong blocks with power brake-applying gear. The material of the block should be softer than the rim of the wheel, so that the former and not the latter is worn away; yet it must be capable of standing a fair amount of crushing pressure. The following table gives the usual practice for the three most common timbers, together with the coefficients and angles of friction on steel tires.

	Pressure per sq. in. surface. Power brakes.	Hand brakes.	μ	θ
Oak ...	50 to 80 lbs.	30 lbs.	0·5 to 0·6	26½° to 30°
Elm ...	50 to 100 „	30 „	0·25	14°
Beech ...	50 to 80 „	30 „	0·25	14°

Let p be the safe pressure per square inch, as given in the above table, and A the required area of brake surface, then

$$A = \frac{N}{p} = \frac{P\ .\ \cos\theta}{p}$$

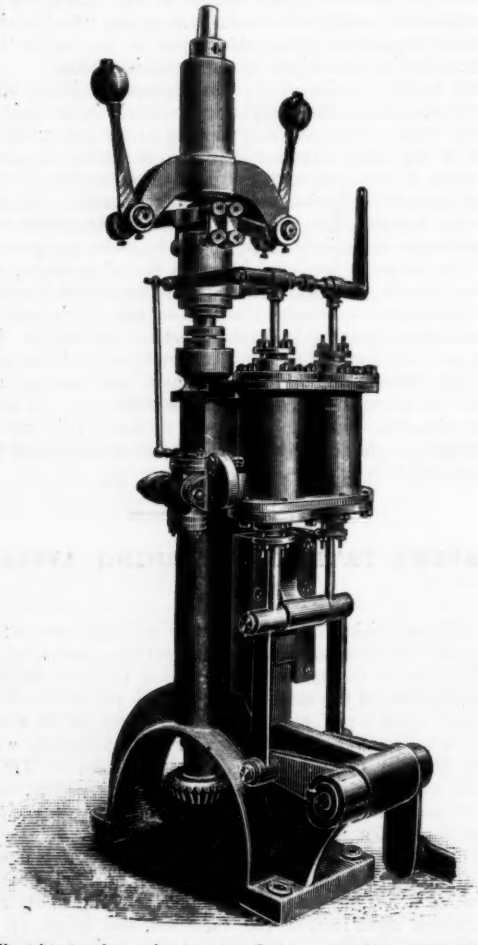
The total amount of brake surface having been obtained, it is good practice to divide this into two or more pairs of blocks; putting each pair on a separate wheel at opposite ends of a diameter, so as to produce as little thrust on the axle as possible. Each block must not be larger than will embrace about one-sixth of the circumference of the rim, as the greater part of the thrust would otherwise be ineffective owing to the curvature of the rim. The total force of friction on any one wheel must be less than the tractive force of that wheel; *i.e.*, it must be less than the grip of the wheel on the ground, otherwise the wheel will skid when the brake is applied. A brake should never be applied so forcibly that the wheel is caused to skid, as thereby the friction on the wheel is reduced and the car takes longer in coming to rest, to say nothing of the wear on the wheel and track. In designing a brake, care should be taken that the separate wheels are not overloaded with brake surface, and that as many wheels on the car are braked as will enable the full brake power to be applied without causing any wheel to skid. The actual number of brake blocks put on any car or train will therefore be determined by these considerations.

Hand brakes require about three seconds to bring them into action. The brake-applying gear should be so designed that full brake power can be applied by a force not exceeding 20 lbs. at the brake-handle. A man can pull with greater force than this; but, where a brake has frequently to be applied, it is not well to expect the brakesman to exert more than this figure. The rods coupling the brake-handle with the blocks are sometimes arranged to be under compression when the brake is applied; but this is bad practice, as it involves the use of stout stiffened rods to obviate bending. It is much better to arrange the gear so that all the rods are under tension when the brake is in action, as rods of light round steel can then be used. If the rods are under tension, a working stress of 8,000 lbs. per square inch section may be used for wrought iron, and 9,000 for mild steel. If under compression, the working stress will depend on the ratio of the length to the least diameter, but will never exceed one-tenth of the above figures.

DALES'S PATENT GOVERNING APPPARATUS.

THE primary object of the inventor of this arrangement was to provide an apparatus for extremely fine governing, and chiefly for such engines as are required to drive ordinary machinery, and at the same time dynamos for direct electric lighting. As a 3 per cent. variation of speed can be seen in an arc or other light, the margin for such variation which *cannot* be seen in the light is extremely small. The endeavour was to produce, in the first place, a governor, which in itself, as an instrument, should be practically perfect for the purpose; that is to say, which would change its position and work through the extreme range of its governing motion, with a variation of speed which could *not* be observed in an electric light. This was estimated at something under 2 per cent., which must include the variation, *both ways*, up and down, from the normal speed; or the desired governing movement with a deviation from the normal speed of only 1 per cent. It was evident that with so small a variation of speed, even from a very powerful governor, practically no force could be given off for the purpose of working expansion valves, and that auxiliary power would have to be provided for that purpose; and further, that the prevention of the oscillatory movement of the governor itself (known as "pumping" or "racing"), which is really over-action and "late" action, would necessitate the reduction of friction, inertia, and momentum to an absolute minimum. The result was the production of an arrangement, the performance of which may be summed up as follows :—The governor will move the auxiliary power apparatus, and stand in its extreme positions with a total difference of speed of about 1 per cent., thus giving the full power of the engine, or only sufficient to drive the normal speed with no load on. The full power of the engine may be absorbed by a brake, which may be instantly released without causing any greater variation of speed than 1¼ per cent. total oscillation. Full steam may be turned on the engine at starting, with no load on, without over-running the normal speed more than 1¼ per cent. total oscillation. The first engine fitted with this apparatus worked high pressure, *i.e.*, non-condensing, and indicated an average of 40 H.P., at a cost for coal of 5d. per hour, or at the rate of 8 H.P. for 1d. per hour, burning small coal of the lowest quality at 4s. 8d. per ton delivered. Reckoning slack at half value of coal (the usual custom), this gives power in small quantity for 2½ lbs. of ordinary common coal per horse-power per hour, working non-condensing and with no steam jacket. The engine was 12 inches cylinder diameter, 16 inches stroke, and ran at 220 revolutions per minute.

As will be seen from the illustration, the governor fork lever is carried between the slider chase and the heads of two piston rods, to which it is connected by means of a rocking shaft. One end of the rocking shaft carries a shorter lever, which is keyed to the same, as is also the governor fork lever, thus making the two practically one.



The shorter lever is connected to a small steam valve on the steam cylinder by a rod or lever. The second cylinder is merely a cataract. The steam valve is of the piston type, and admits and exhausts steam to both ends of the cylinder as by an engine slide valve. The principles involved in the action of the gear are that the governor always opens the steam valve for moving the expansion gear by the steam piston, and the motion of the pistons always closes the valve, the motion of the pistons produced being always the reverse of that of the governor.

Any tendency of the work to force the steam piston out of position causes an action of the valve, which opposes the steam pressure to such tendency. The position of the governor slider and the steam piston thus always correspond.

The uselessness of any direct acting arrangement of centrifugal governor for moving a heavy expansion gear through any useful range of distance may, perhaps, be most easily and fitly illustrated by the mention of the fact that, with a variation of 1 per cent. in speed, the above apparatus exerts as much force as a direct acting centrifugal governor, having a centrifugal force of 17,000 lbs. would do, and it has the advantage of moving through any desired distance, which would be an especial difficulty with a direct-acting governor, even of the enormous proportions required to generate the same force. In short, a direct-acting governor of equal power is impracticable on an ordinary engine.

For electric lighting, and similar purposes, the economical importance of good governing is so generally recognised, that the above apparatus will doubtless soon find many applications.

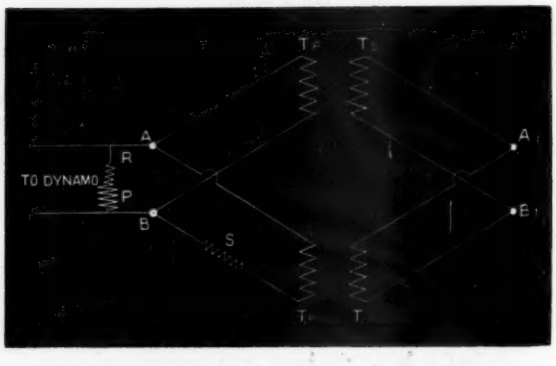
It is being introduced by Messrs. E. Gillate & Co., Coldharbour Lane, London, S.E. The illustration shows a governor capable of exerting a force of 700 lbs.

TESTING TRANSFORMERS.

DR. SUMPNER has recently published a new method of determining the net efficiency of alternating transformers, which promises to find no little favour in general practice, for it is at any rate applicable to the workshop, if the latter be supplied with suitable current and volt reading instruments. Hitherto the practical method has been to measure the watts in the secondary and primary circuits, and take the efficiency as being the ratio between the two values. If these two quantities could be accurately measured, nothing could be simpler. But, unfortunately, an error in either reading makes a corresponding error in the efficiency value. To obviate the want of accuracy due to imperfect commercial instruments, Dr. Hopkinson has lately endeavoured to measure the losses directly, and then to deduce the efficiency by comparing these losses with the output; so that the efficiency $= E = 1 - \frac{w}{W}$ where w = the losses and W the load, both being expressed in watts. And since the efficiency of a transformer at full load is about 95 per cent., w will be only about $\frac{1}{20}$th of W; and therefore an error of 1 per cent. in either of the determinations will only make an error of $\frac{1}{20}$th part of 1 per cent. in the efficiency. The method devised by Dr. Hopkinson is undoubtedly capable of great accuracy, but it is too complicated for ordinary work.

On the contrary, that devised by Dr. Sumpner, while admitting of as great accuracy, is, as we have said before, suitable for application in the ordinary testing room. But it has this limitation; the losses are measured as a whole and not in detail as by Dr. Hopkinson's more complex arrangement.

It is unnecessary to describe fully the four cases referred to by Dr. Sumpner. A brief description of the method proposed



as most practicable will be sufficient. Three transformers are required; two whose joint efficiency is to be determined and a smaller one to supply the energy lost over the two tests. The arrangement is clearly represented in the diagram:—A, B, are the dynamo mains; A_1, B_1 are the transformer mains; R is a non-inductive resistance in series with the primary circuit P, of the small transformer, which is coupled across the dynamo mains. S is the secondary circuit of this small transformer, and it is in series with either the primary or the secondary circuit of one of the large transformers; in the diagram it is shown in the primary circuit of T_1. T and T_1 are the large transformers, and T_p and T_{1p} the primary coils, and T_s and T_{1s} the secondary.

It will be noted that the transformers are in parallel. In making the test the current in the large transformers can be regulated by the output of the small secondary, S, which can be varied by the resistance, R.

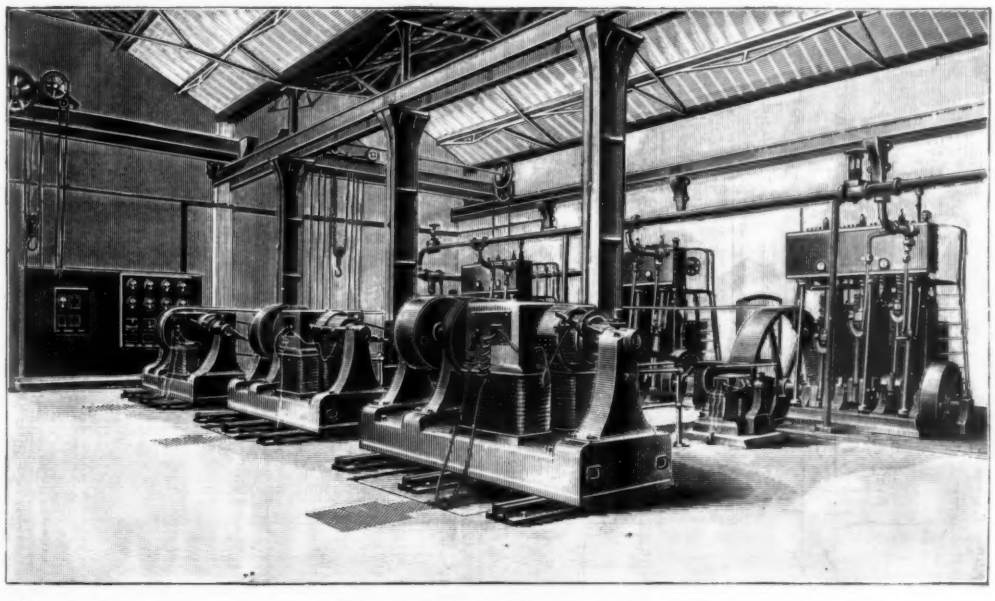
For further particulars we refer our readers to Dr. Sumpner's description of the method.

Visitors to the Chicago Exhibition.—The managers of the Chicago Exhibition are, we understand, already netting a revenue from the curiosity which is felt with regard to the show. It has been arranged to admit visitors to see the grounds of the buildings now approaching completion at the rate of 1s. per head, and on single days in the early part of this month the number of visitors has exceeded 14,000.

THE SUPPLY OF ELECTRICITY AT OXFORD.

THE conditions of electrically lighting towns in England will differ so widely, that it need not be surprising if the peculiar needs of a district bring out here and there some schemes which possess greater utility than a mere suitability for the district for which it was designed.

English towns have not grown along with electricity, for the most part they existed in the good old days when oil lamps hung from the middle of the principal streets and cast a feeble light around, hence the electric light must become adapted to the special wants of old fashioned houses, old fashioned streets, very often of old fashioned inhabitants. Local authorities, again, are usually possessed of prejudices, gained from more or less doubtful sources, nevertheless they are a force which must be reckoned with. A town authority without some special theory as to the best means of lighting is a rarity, and sometimes they have a fatuous obstructive manner bred in them from hasty generalising, and very often do they become stiff-necked opponents of the alternating current, solely on account of the accidents which have happened when this system has been used. Necessity is the mother of invention, and perhaps, after all, we may be thankful that varying local conditions will compel many departures from stereotyped work.



GENERAL VIEW OF CENTRAL STATION.

THE SYSTEM.

We have described in a previous issue * the system of electric lighting used in Oxford; but it may not be out of place to recapitulate the chief points in Mr. Parker's method of continuous current transformation.

The generators are placed in a central station, which is built on the most convenient spot for water and the delivery of coals. A pressure of 1,000 volts is sent from here to the motor transformers, which are placed in sub-stations at different points of the district to be lighted.

The main feature of the system is the arrangement whereby all the transformers in a district to be supplied can be completely controlled from a switch station situated in the middle of the district, the high tension current being supplied from dynamos running in parallel at the distant generating station to omnibus bars on the switchboard, from which it is distributed through separate switches to the high tension armature of each transformer. A voltmeter above each switch is connected by pilot wires to the point in the secondary network at which the low tension armatures supply current, and the high tension and low tension armatures of the transformers are connected and disconnected from the high tension omnibus bars and low tension network, respectively, according to the number of lights in use at one time, varying the number of transformers running with the conditions of the load during each part of the day. In this manner it is never necessary to run any transformer with less than 50 per cent. of its full load, and as the machines, according to the makers, yield an efficiency of 84 per cent. at half load, and 90 per cent. at full load, it is expected that the total efficiency of distribution will be very high.

Referring to the diagram of the system, it will be seen that the high tension feeders are connected to the omnibus bars by means of the double pole switches, the regulating resistance preventing a momentary excess of current. The current is supplied to the armature through a few turns of highly insulated wire wound round the magnets of the transformers, which partly magnetise the field, and passing through the high tension armature, causes the transformer to rotate when the low tension armature generates an E.M.F., and the main magnetising coils, being connected as a shunt across the low tension armature, energises the field to the full extent. The resistance is now cut out of the high tension circuit, until the E.M.F. on the secondary armature is equal to the E.M.F. on the low tension mains, as indicated on the voltmeter, V. The low tension armature is then switched on to the mains as follows:—One of the voltmeter wires is connected to the mains through the winding of a magnetic switch, shown diagrammatically at S, the small current constantly passing through the voltmeter being insufficient to affect the switch. A switch is arranged at the switch station to short circuit the voltmeter, which allows the full current required by the magnetic switch to pass through the wires, and cause the magnet, I, to ascend, when the circuit is again broken at the voltmeter switch, allowing the magnet, I, to descend again. The double movement rotates the cam wheel through one-eighth of a revolution, and pressing the contact piece into the brushes of the switch, S, thus connects the low tension armature to the low tension mains. The voltmeter, only being momentarily short-circuited, reads, as before, across the mains. The E.M.F. on the voltmeter is kept constant by means of the regulating resistance in the high tension feeders, and the transformer is disconnected from the mains when the amount of current being supplied, as indicated on the ammeter, A, falls below a certain amount.

On disconnecting the transformer again, the resistance is once more inserted, until the current falls to zero, indicating that the E.M.F. on the secondary armature is too low to supply any current to the mains, the switch, S, is then broken by again short-circuiting the voltmeter, rotating the cam

* November 20th, 1891.

wheel through another one-eighth of a revolution, and allowing the springs to pull the contact piece from the brushes. Thus there is no sparking at the brushes of the switch, S, as, under ordinary circumstances, the circuit through it is never broken while any current is flowing through it. The magnet, M, is connected to the low tension feeders in such a manner, that should the low tension armature be switched on to the mains before the high tension armature, or before the low tension armature is giving sufficient E.M.F., the excess of current flowing back from the low tension mains will cause the armature of the magnet, M, to be attracted, knocking round the cam wheel slightly, and breaking the circuit at S, again, but leaving the switch ready to be "made" again when necessary from the switch station.

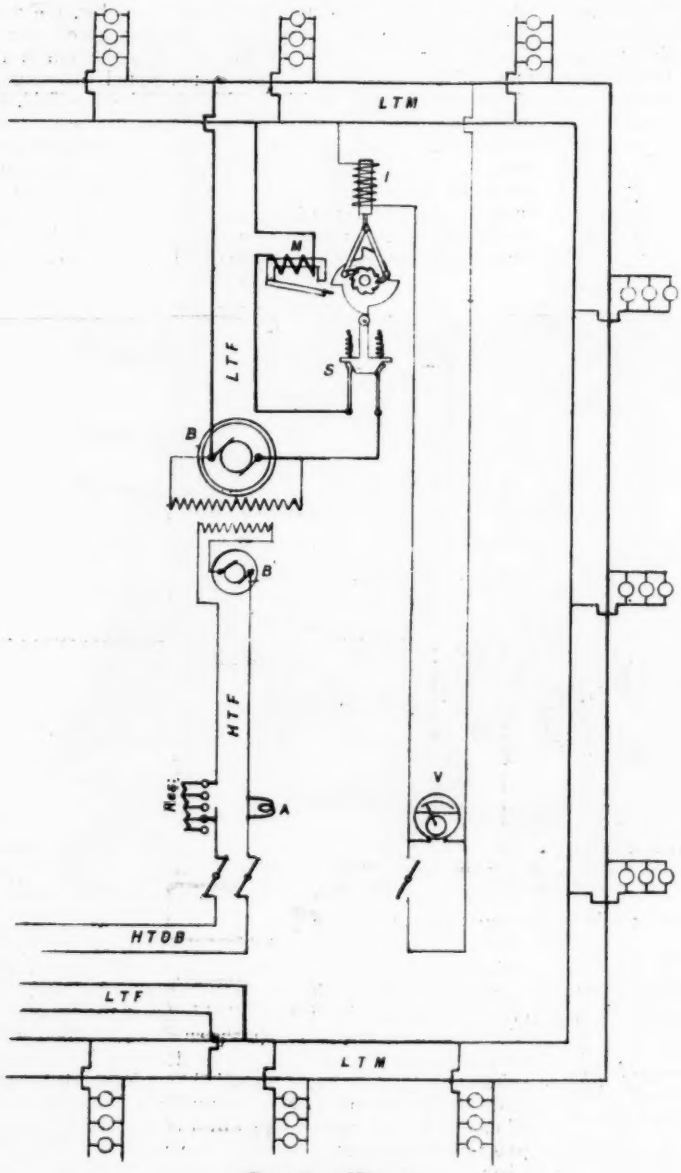
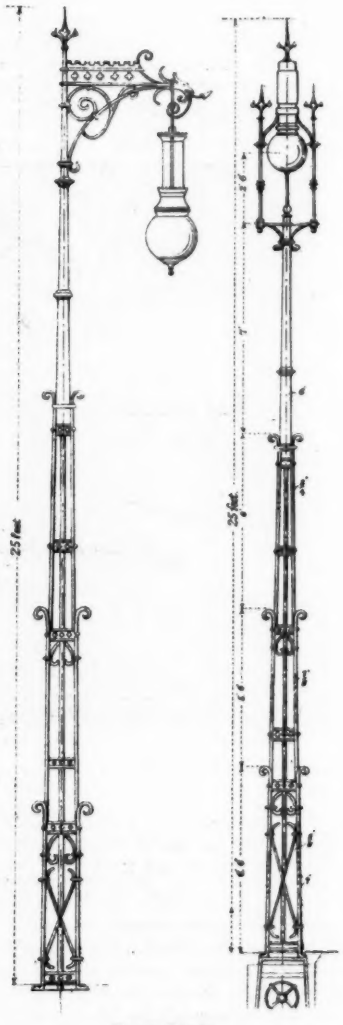


DIAGRAM OF SYSTEM.



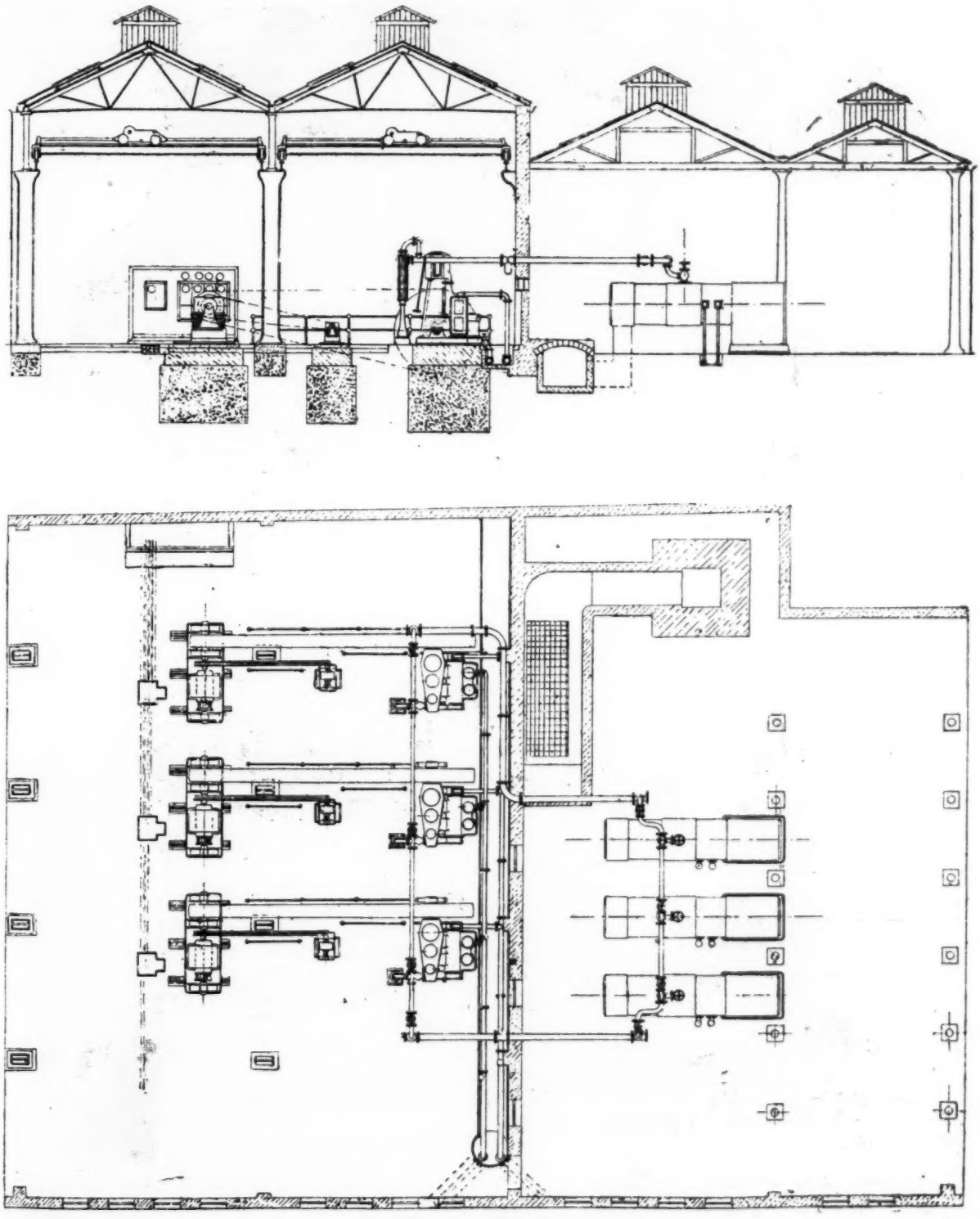
LAMP POSTS.

THE CENTRAL STATION AND SUB-STATION.

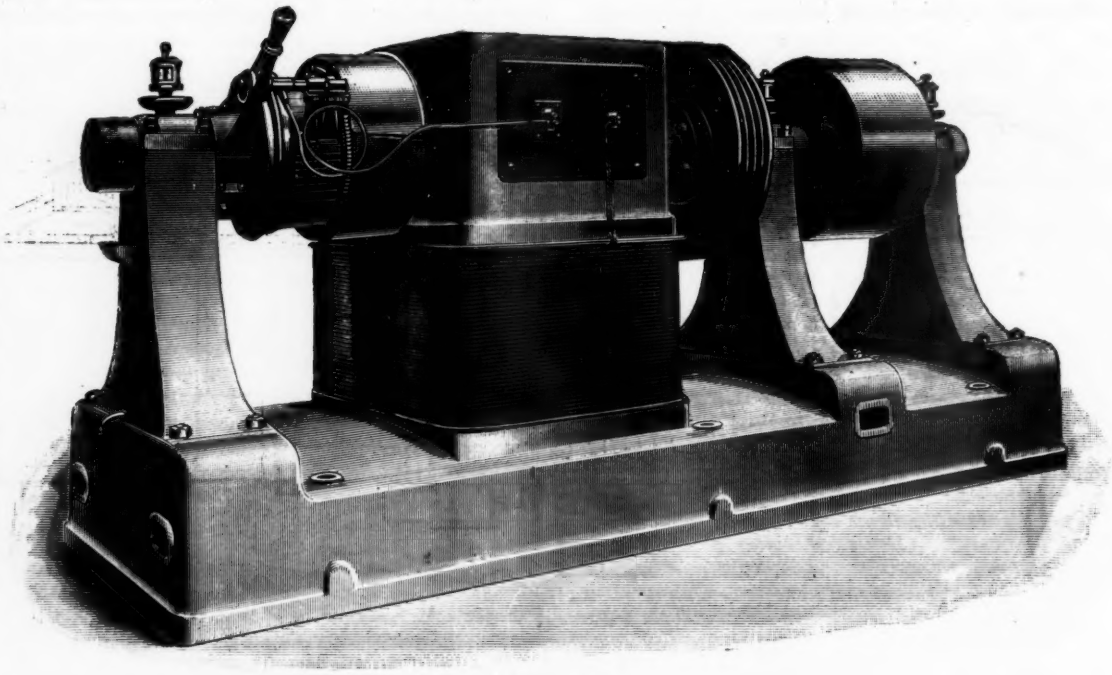
The provisional order under which the electric lighting of Oxford is carried out, was originally acquired by the Electric Installation and Maintenance Company, and was by them transferred to the Electric Construction Corporation, who, in their turn, have sold the business to a local company. Availing themselves to the full of the peculiar advantages offered by their system, the company was able to make a free choice of land, and selected a site for the central station at Osney, by the side of the river Isis, in a quarter of the town where there is likely to be little grumbling on the ground of the generating station being a nuisance. The building in which the plant is at present fixed is built of brick, 80 feet by 60 feet. The dynamos made by the Electric Construction Corporation are at the moment three in number, driven by Gaskin link belting from three McLaren compound condensing engines. The dynamos are designed to give 80 ampères at 400 revolutions at a pressure of 1,080 volts, and are fitted with extra bearing on the outside of the pulley. They are separately excited by small Elwell-Parker dynamos, driven from a rope pulley, keyed on to the shaft of the main generator. These exciters are arranged to give 135 volts, so as to charge the accumulators, which are used for lighting the central station. The E.M.F. of the dynamos may be regulated from 1,100 volts at full load, to 1,000 volts at light load, by means of resistances placed in circuit with the exciters. Each dynamo has in circuit an automatic magnetic cut-out, which protects the dynamo in the event of any short circuit or excessive current, and which may be reset by hand. It will be seen that the machines are placed on two rails, which is done so that they may be moved with ease when slackening or tightening the belts. The foundations on which the dynamos stand is of concrete 10 feet in depth.

The McLaren engine is not often met with in central station work, although its performance appears to be very good. The diameter of the cylinders is H.P. 9 inches M.P.

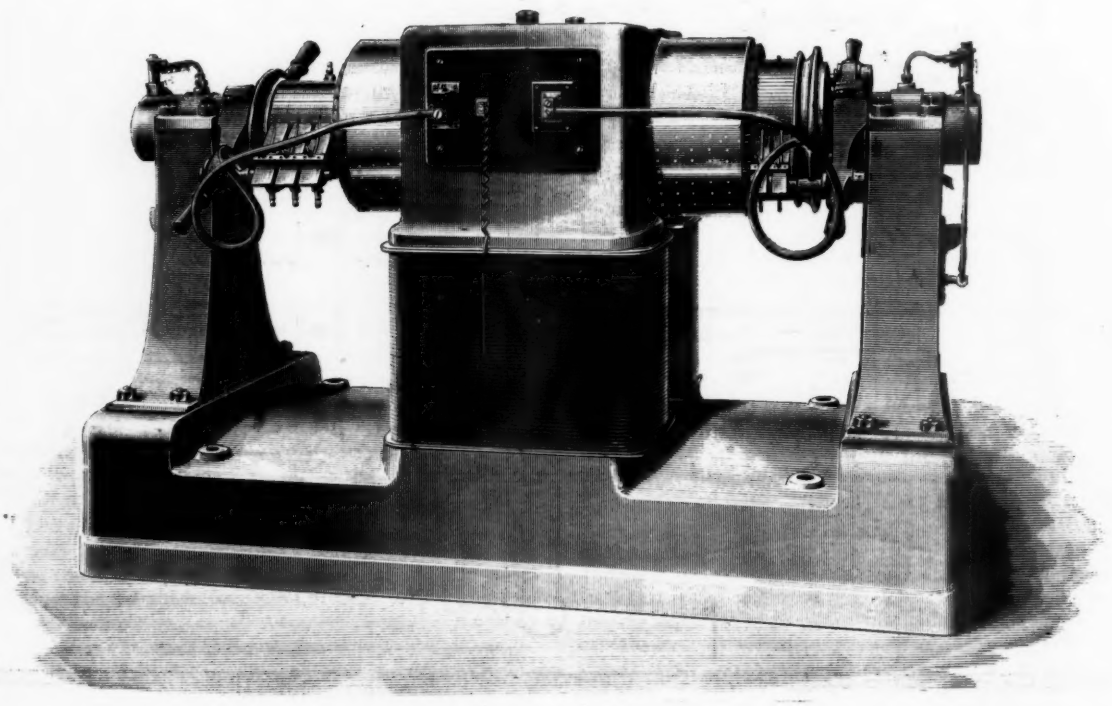
14½ L.P. 22½, with 24 inch stroke. It is designed to run at 125 revolutions, is surface condensing, and usually works at a pressure of 160 lbs. The high-pressure and intermediate cylinders are jacketted with steam at boiler pressure, and are drained through a McDougal steam trap into the hot well. The low-pressure cylinder is not jacketted. The McLaren automatic governor is placed inside the fly-wheel upon the shaft itself, and it works direct on to the high-pressure slide valve, which is not balanced in any way. The governor is self-locking, and is therefore not affected by any friction on the slide valve. The engines run very steadily, and all danger of the governor being put out of gear by the breaking of a belt is obviated. The surface condenser is fitted with brass tubes and tube plates; the tubes are ¾ inch outside diameter, and there is 382 square feet of cooling surface. The air pump is 11½ inches diameter, the circulating pump 10 inches diameter, and the feed pump 1¾ inches diameter, all three having a stroke of 14 inches. The pumps are placed behind the condenser, and are worked by levers from the intermediate engine. The crank shaft is of forged steel, 5¼ inches diameter, the crank pins 5½ inches diameter, and the engines are thoroughly well finished.



PLAN AND SECTION OF STATION.



Dynamo.



Continuous Current Transformer.

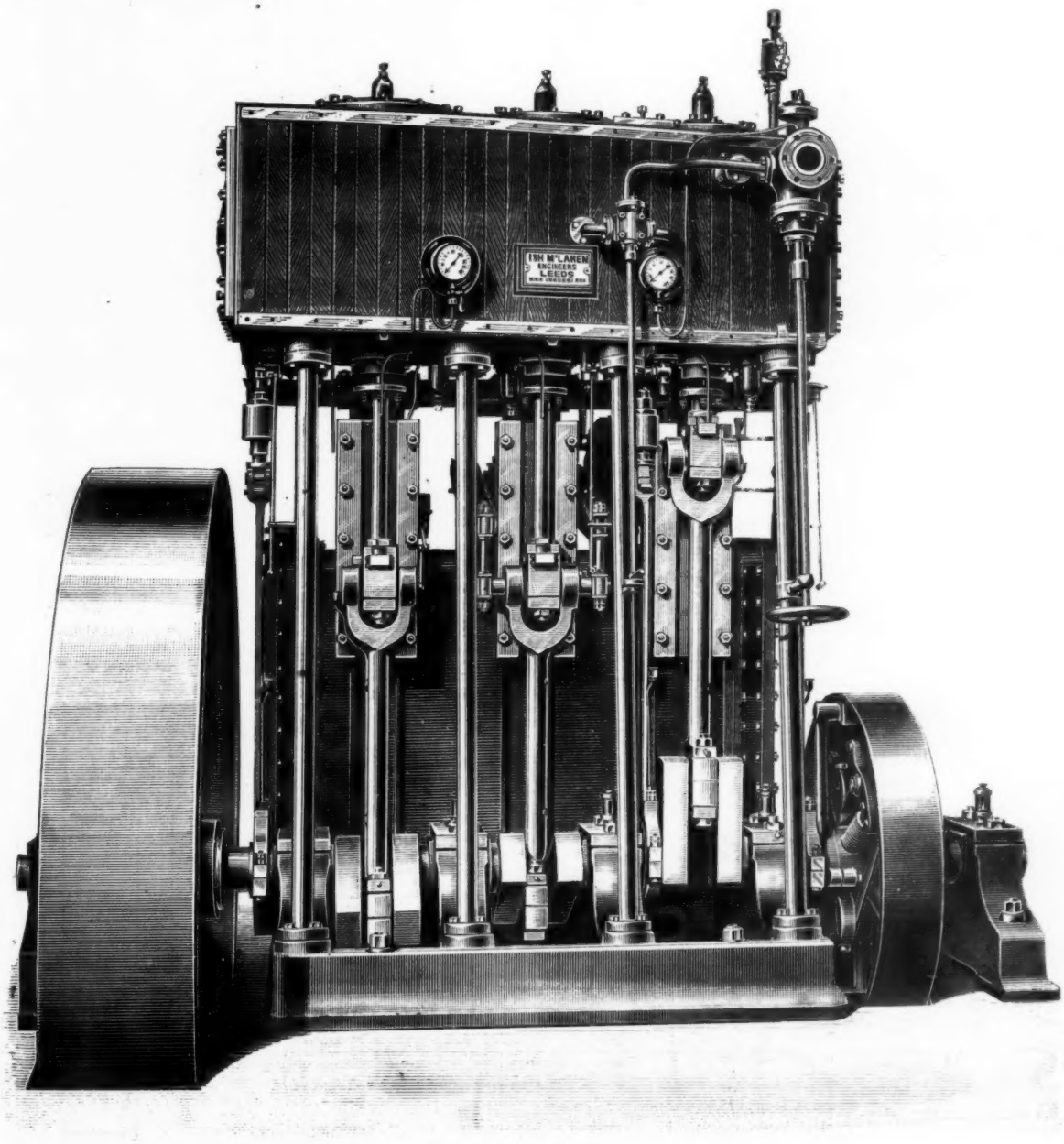
During recent tests of this engine only 1·3 lbs. of coal per I.H.P. are said to have been used, and it is expected that better results than this will be obtained at Oxford.

There are two switchboards, the one containing the dynamo meters, the other showing the total current going out from the station. We illustrate the automatic transformer switch, the working of which is shown in the beginning of this article.

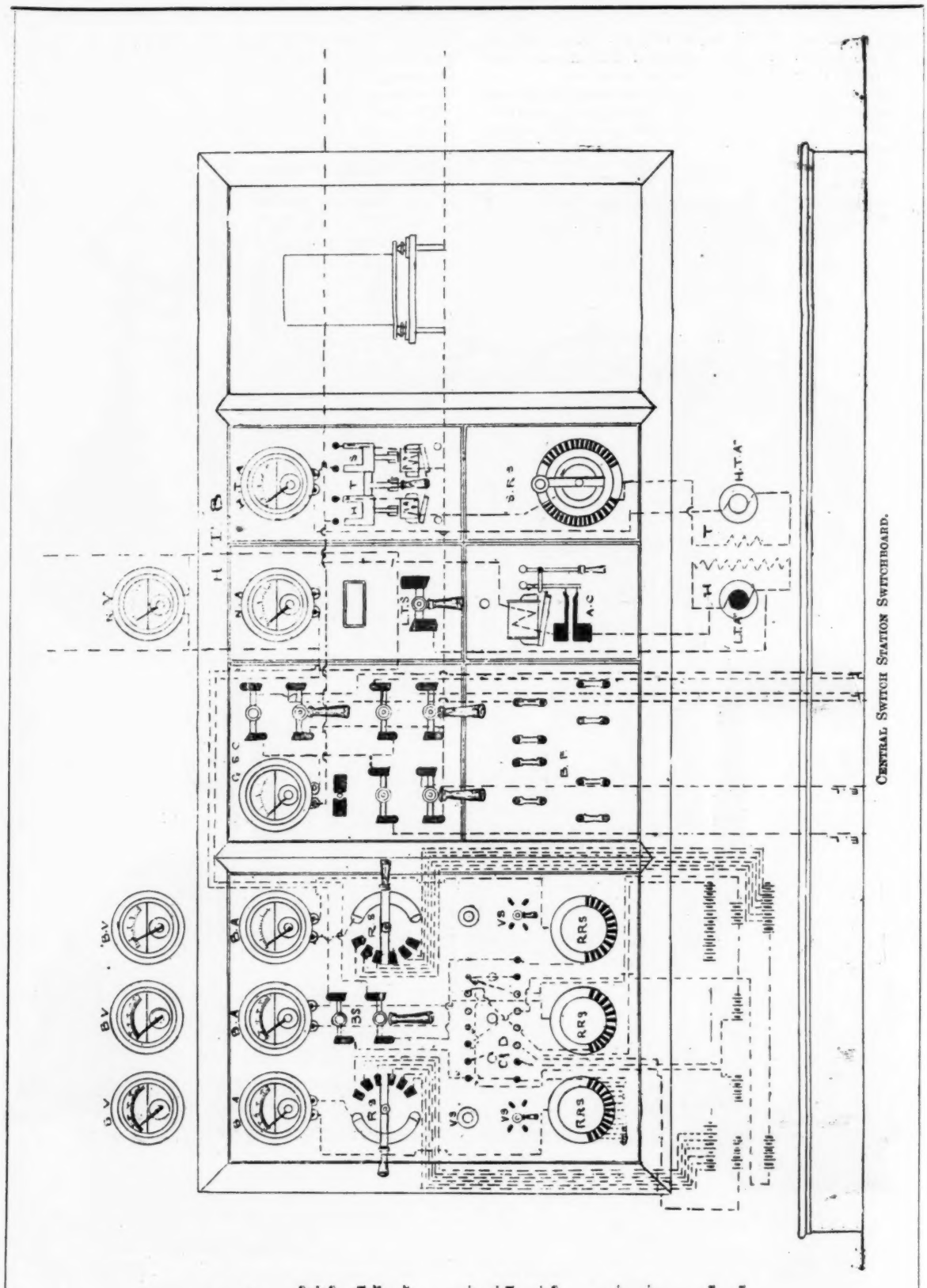
From the central station the current is taken to the switch station, at Broad Street, by means of two pairs of high tension cables in iron pipes, so arranged that they may be placed in parallel when required. It is proposed to run the dynamos themselves always in parallel, thus insuring that any mishap to one machine shall not cause an extinction of the lights.

At Broad Street switch station there are installed two sets of accumulators and a continuous current transformer. The accumulators are capable of discharging at a rate of 120 ampères for 8 hours. The transformer is designed to run from a 1,000-volt circuit, and to give 360 ampères at 110 volts on the secondary circuit. All the transformers are fitted with oil pumps, and as the brushes require no lead, the machines themselves will want but little attention. Similar transformers are placed in Queen Street and King Street, and are started and stopped by means of the switch gear at the Broad Street Station itself.

The continuous-current transformer is similar to those shown at the Crystal Palace Exhibition and used by the Crystal Palace District Electric Lighting Company for supplying current to the various exhibits. This machine has two distinct windings, the secondary giving an E.M.F. of 110 volts, and 360 ampères, and the primary winding giving 1,000 volts, when running at a speed of 550 revolutions per minute. In this case the field magnets are excited previous to starting the machines, and to do this effectually the field of the first machine is excited by a current from accumulators. A high-tension current is switched on to the brushes through a resistance. The secondary circuit is afterwards switched on to the feeders, a portion of this current being taken to excite the field magnet of the next machine. The bearings are supplied by special oil pumps so as to give ample lubrication and enable machines to run continuously without attention.

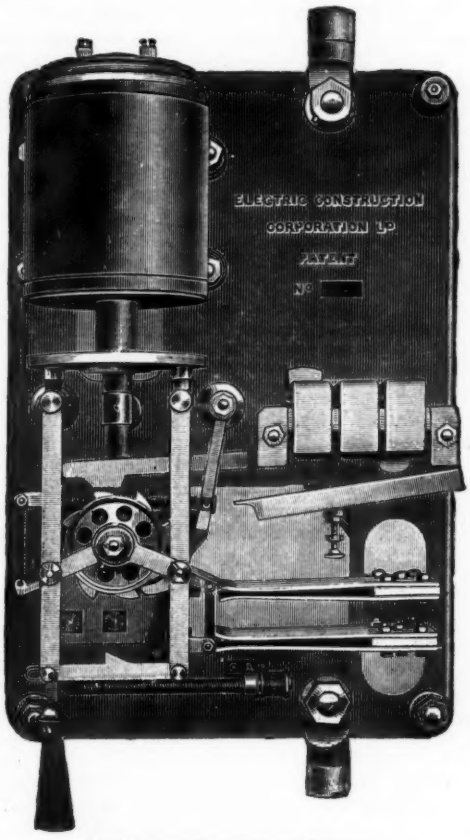


THE MCLAREN ENGINE.


B V .. Battery voltmeters.
B A .. Battery ammeter.
R S .. Regulating switches.
B S .. Battery switch.
V S .. Voltmeter switch.
C and D Throw-over charge and discharge switch.
R H S .. Regulating resistance switch.
G S C .. Main ammeter and switches, generating station circuits.
H T B .. Home transformer boards.
N A .. Network ammeter.
N V .. Network voltmeter.
H T A .. High tension ammeter.
H T S .. High tension automatic cut-out and switch.
S R S .. Starting and regulating resistance switch.
H T .. Home transformer.
P V .. Pilot voltmeters.
H T A' .. High tension armature.
L T A" .. Low tension armature.
L T H .. Low tension switch.
A C .. Automatic cut-out.
F E L .. Future extension leads.
G E L .. Generating station leads.
B F .. Battery fuses.
CENTRAL SWITCH STATION SWITCHBOARD.

The efficiency curve of this machine, which was published in our issue of February 26th, shows a high standard.

We are able to give drawings of the type of lamp-post intended to be used. With a view to encourage home industries, these columns are brought over from Munich.



AUTOMATIC TRANSFORMER SWITCH.

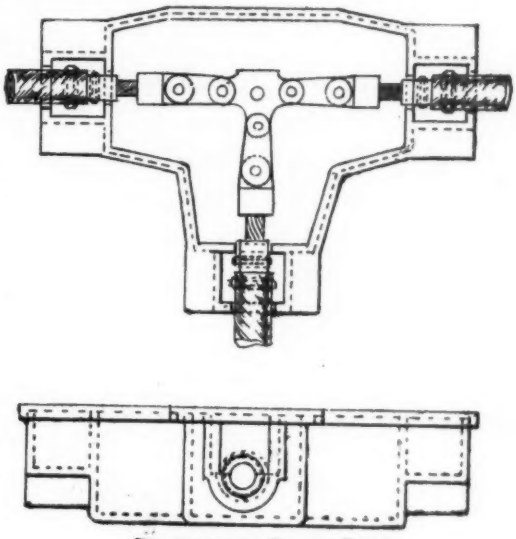
The cables for the distributing network have been manufactured and laid by Callender's Bitumen Telegraph and Waterproof Company, Limited, under the supervision of their resident engineer, Mr. W. Douglas Reid.

The cables are of two sizes, viz., $\frac{1}{2}$ inch section and $\frac{1}{4}$ inch section, and are of the lead sheathed and armoured type, the armour consisting of two layers of steel tape.

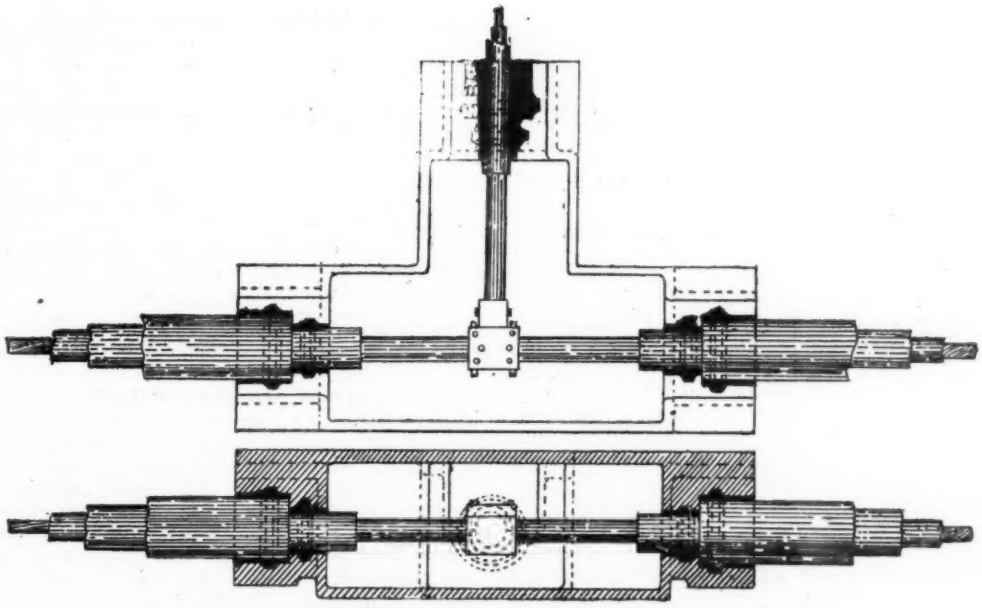
The cables are simply laid in a trench under the footway, at a depth of about 18 inches. They are laid in lengths varying from 150 yards to 200 yards, and are connected together in cast-iron joint boxes with copper connectors. The box is then run in solid with bitumenised wax compound.

Disconnecting branch boxes are provided at different points in the network, so that any section or street can be cut out, without in any way interrupting the supply to the other portion of the network.

House services are laid on when required, the joints to the mains being made in T-boxes with T-copper connectors.



DISCONNECTING BRANCH BOX.



JUNCTION BOX, SHOWING CONNECTIONS OF BRANCHES AND SERVICES.

CABLES.

The high pressure feeders are of Silvertown make, and consist of two pairs of trunk mains from the generating station to distributing station, *i.e.*, four cables each of 37/14 copper, insulated with vulcanised rubber, and then laid in a cast-iron pipe.

These boxes and connectors are so made that the cable has not to be cut. The cable is simply bared down to the copper strand and the connector put on and soldered, and then the box is run in solid with bitumenised wax compound.

The small service cables are of two sizes, 7 No. 14, and 19 No. 14 lead sheathed and armoured.

The arc light cables are also 7/16 lead sheathed and armoured.

GENERAL REMARKS.

It is difficult to say what measure of success will be reaped by the Oxford Electric Lighting Company. It seems to us that much, if not all, will depend on the colleges taking electric light. The college heads have in days gone by burned martyrs, but they have never burned gas; if, now that electricity is at their doors they fail to avail themselves of it, enlightenment has not yet dawned on the University of Oxford.

The general manager of the company is Mr. George Offor; the chairman, Mr. Irving Courtenay. Mr. McLean, who has superintended the erection of the plant, is now in charge of the station.

CRYSTAL PALACE ELECTRICAL EXHIBITION AWARDS.

THE following are the awards made by the jurors:—

DIPLOMA OF HONOUR.—H.M. Post Office, L. B. & S. C. Railway Co., L. C. & D. Railway Co., L. & N. W. Railway Co., National Telephone Co., Exchange Telegraph Co., Crossley Bros., Swinburne, J. and Co., Willans & Robinson.

DIPLOMA OF HONOUR AND GOLD MEDAL—(Highest Award).—Brush Electrical Engineering Co., Crompton & Co., Edison & Swan United Electric Light Co., Johnson & Phillips, Siemens Bros. & Co., Limited.

GOLD MEDAL.—Coxeter & Son, Davey, Paxman & Co., Easton and Anderson, Electric Construction Corporation, Electrical Power Storage Co., Glover, W. T. & Co., Henley's, W. T., Telegraph Works Co., The Laing, Wharton & Down Construction Syndicate, Nalder Bros. & Co., Saxby and Farmer, White, J.

SILVER MEDAL.—Acme Electric Co., Anderson, R. & Co., Andrew, J. E. H., Andrews, J. D. F. & Co., Armstrong's Glass Co., Barclay and Son, Benham & Froud, Bristol, L., Britannia Rubber & Kamptulicon Co., British Gas Engine Co., British Stone & Marble Co., Browett, Lindley & Co., Campbell Gas Engine Co., Chubb & Son, Consolidated Telephone Co., Davis & Timmins, Day & Co. (Bath), Dent & Co., Dick, Kerr & Co., Edison Manufacturing Co., Epstein Accumulator Co., Ferranti, Ltd., Fielding & Platt, Fowler-Waring Cables Co., General Electric Co., Giles, F. & Co., Groves, W., Groth, L. A., Gülcher Electric Light & Power Co., Hammer, W. J., Joel, H. F., & Co., Laing, Wharton & Down, Lloyd & Lloyd, London Metallurgical Co., Mosses and Mitchell, Osler & Co., Rashleigh Phipps & Dawson, Richard Freres, Richards, F. M., Scott, Ronald A., Shirley & Co., Trent Gas Engine Co., Warby, J. L., Waygood & Co., Wells Bros., Western Electric Co., Weymersch Battery Syndicate, Woodhouse & Rawson.

BRONZE MEDAL.—Allsop & Co., Anders, Elliot and Chetham Strode, Appleton, Burbey & Williamson, Archer Pipe Co., Becker & Co., Bishop, W. J., Bowron, G., Burnby & Son, Capitaine Gas Engine Co., Charlesworth, Hall & Co., Cooper, H. & J., Croggon & Co., Dorman and Smith, Electric Stores, Ltd., Faraday & Son, Fowler, Lancaster and Co., Habgood, W. J., Hindley, E. S., Hookham, Townley & Co., Homacoustic Speaking Tube Co., International Electric Co., Jenner, T., Jennings, G., Jooss, A., Lacombe & Co., Lewis, J., Lundberg, A. P., Maquay Electric Light Syndicate, Mayer, H., Mining and General Electric Lamp Co., Napier & Son, Newton, F. M., Riedel, J., Roberts, Adlard & Co., Roper's Electrical Engineering Co., Smith, Samuel and Son, Spencer, Edward & Co., Spencer, J., Stegmann, G., Taylor and Tucker, Telegraph Manufacturing Co., Thorpe, Harry, Tipping, H. S., "Trusty" engine, Wilson Hartnell, Ziety & Co.

JURORS.—Prof. W. Grylls Adams, D.Sc., F.R.S., Mr. L. Atkinson, Prof. W. E. Ayrton, F.R.S., Mr. Shelford Bidwell, M.A., F.R.S., Mr. Conrad W. Cooke, M.Inst.E.E., Prof. W. Crookes, F.R.S., Mr. W. B. Esson, M.Inst.E.E., Prof. Geo. Forbes, M.A., F.R.S., Major-General Festing, R.E., F.R.S., Capt. Sir Douglas Galton, K.C.B., F.R.S., Dr. J. H. Gladstone, F.R.S., Mr. J. H. Greathead, M.Inst.C.E., Mr. Chas. Hall, M.Inst.E.E., Prof. D. E. Hughes, F.R.S., Sir. Hy. C. Mance, C.I.E., Mr. W. H. Massey, M.Inst.C.E., Prof. J. Perry, F.R.S., Mr. W. H. Preece, F.R.S., Mr. A. Reckenzaun, Prof. Hy. Robinson, M.Inst.C.E., Capt. Sankey, R.E., M.Inst.E.E., Mr. C. E. P. Spagnoletti, M.Inst.C.E., Mr. Albion T. Snell, Mr. W. E. Sumpner, D.Sc. Mr. Jas. Swinburne, M.Inst.E.E., Prof. Silvanus Thompson, D.Sc., F.R.S., Mr. J. Tomlinson. M.Inst.C.E., Prof. W. C. Unwin, B.Sc., M.Inst.C.E., Major-General Webber, C.B., R.E., Mr. J. W. Wilson, M.Inst.C.E.

Laundry Exhibition.—Messrs. Harry Etherington & Co., who have for the past 15 years organised the Sportsman's, Food and Cookery, Ironmongers', and other Trade Exhibitions, inform us that they have arranged to hold a Laundry and Domestic Appliances Exhibition at the Central Hall, Holborn, London, in August next. This should be a good opportunity for public demonstration of the applicability of electricity to the working of all kinds of domestic machinery. Plans, prospectuses, and all particulars can be obtained at the offices, 43, New Oxford Street, London, W.C.

NOTES.

The Varley Testimonial.—A meeting was held at the Westminster Palace Hotel on July 1st for the purpose of discussing the subject of the Varley testimonial. A considerable number of gentlemen were present including Lord Kelvin, Major Flood Page, Mr. A. Siemens, Profs. D. E. Hughes, John Perry, Silvanus P. Thompson, and George Forbes, Messrs. T. E. Gatehouse, R. E. Crompton, A. Stroh, W. Gorman, and others. Lord Kelvin took the chair. A number of letters were read from gentlemen who were unable to attend, but who had signified their hearty assent with the objects of the meeting; among these were Sir. F. Bramwell, Sir H. Mance, Sir Leppoc Cappel, Sir D. Galton, Sir J. Pender, Dr. Gladstone, Mr. W. H. Preece, Profs. Ayrton, Kennedy, Lodge, and Fitzgerald, Messrs. J. W. Swan, Belshaw, J. E. H. Gordon, Manville, Massey, R. K. Gray, Jackson, and Goolden. Mr. T. E. Gatehouse then gave a very interesting account of Mr. Varley's life, and the services that he had rendered to electrical engineering. After some remarks by Mr. Crompton, Major Flood Page, Mr. Siemens, and Profs. Thompson and Perry, the following resolution was put and carried: "That this meeting approves of a testimonial being got up on behalf of Mr. S. Varley, that the whole of those gentlemen who have given their names as willing to serve on the committee be, and are hereby appointed a committee to act in the question of the Varley testimonial, and that an executive committee be hereby appointed, consisting of Lord Kelvin, Prof. S. P. Thompson, Prof. Perry, Mr. A. Siemens, and the gentlemen who attended the preliminary meeting." Among other matters it was suggested that the aid of the Institution of Electrical Engineers be sought to ask that the Government should grant a pension to Mr. Varley; and further that a statement setting forth what Mr. Varley has done should be prepared by Messrs. A. Siemens, T. E. Gatehouse, Silvanus P. Thompson, and R. E. Crompton, and that this statement should be circulated as widely as possible among members of the electrical profession at home and abroad. That the general committee should consist of the names of the gentlemen who had attended the preliminary meeting, also those who had attended that day, and all the gentlemen who had written expressing their sympathy with the objects of the meeting, and that every effort should be made to extend the list.

High Speed Electrical Transit.—Every now and then, says *Industries*, a new scheme is brought out for running trains at a speed of 100 miles an hour or more by electrical means. An express locomotive develops, say, 1,000 H.P. at 60 miles an hour, yet the rapid transit enthusiast proposes to work with about a quarter of this power, and to obtain nearly twice the speed. The proposal generally consists in a scheme for using very light rolling stock, and very efficient motors. It would be well for those who are working at such schemes to obtain trustworthy information as to the air resistance of an ordinary train, and to find from that what power would be necessary to drive one at 100 miles an hour through still air, or against a head wind.

[Dr. Wellington Adams, whose high speed scheme we touched upon last week, might with advantage dwell upon these hints.]

The Theory of Secondary Batteries.—A small war has been raging for some time between Messrs. Gladstone and Hibbert on one side, and Messrs. Armstrong and Robertson on the other. The strife is about the cause of the high initial electromotive force of secondary batteries. Messrs. Gladstone and Hibbert say it is due to strong acid; Messrs. Armstrong and Robertson are ready to maintain to the death that it is due to per-sulphuric acid. The rest of the world, says *Industries*, takes little interest in the matter, but would like better batteries. Each combatant "blows holes" in the other's experiments. Messrs. Gladstone and Hibbert have made a flank movement by repeating the experiments with phosphoric instead of sulphuric acid, on the ground that there is no such thing as per-phosphoric acid. Whether Messrs. Armstrong and Robertson will repel their attack on this quarter is to be seen. They will probably carry the war into the enemy's country in a totally different direction, so that the discussion will be interminable.

Insulating Saddle Staples.—Referring to our description of insulating saddle staples in last week's issue, Mr. G. A. Nussbaum informs us that he has made this kind of staple for some time, and protected same some years ago.

Electric Locomotives for Short Steam Roads.—The North American Railway Company have placed orders with Mr. Sprague and with the Thomson-Houston Company each for one electric locomotive of not less than 700 H.P. The Baltimore and Ohio Railway Company have also resolved to equip the tunnel of the Baltimore Belt Railway with electric locomotives. The terms of the contract were arranged about the end of May. It comprises three 80-ton locomotives, each to develop a pull on the drag bars of 31,000 pounds at a speed of 15 miles per hour. This will make the City and South London Electric Railway look small.

Hampstead Electric Lighting Order.—The Hampstead Electric Lighting Order, which was promoted by the Vestry of St. John's Hampstead, has been confirmed.

The Electric Light in Italy.—The new central station erected at Tivoli, about 20 miles from Rome, to be used in connection with the electric lighting of the latter place was inaugurated on the 4th inst., in the presence of the Italian Minister of Public Works, when the current was transmitted to Rome, and employed in the lighting of the Via Porta Pia. The whole of the plant in connection with the work has been supplied by Messrs. Ganz and Co., of Budapest, Austria.

Society of Arts.—On Wednesday, June 29th, at their meeting, held after the annual election, the Council of the Society of Arts elected Sir Richard Webster, Attorney-General, Q.C., as chairman, and Sir Frederick Bramwell, Bart., D.C.L., F.R.S., as deputy-chairman, for the ensuing year. The various committees were also re-appointed.

Barnet Electric Lighting.—Among our business notices will be found particulars relating to the arbitration between Messrs. H. F. Joel & Co. and the Barnet Local Board. The Barnet installation has, from its commencement, attracted much attention, and has been severely criticised; but the result of the arbitration clearly shows where the fault lays, and Messrs. Joel can fairly claim that they carried the contract through to a successful issue as far as was in their power.

Mr. Cyrus Field.—Telegrams from Newport on 2nd inst. stated Mr. Cyrus Field, who has been ill for some time past, to be failing rapidly. He was unconscious and death was imminent. No further news has been yet received.

Private Electric Lighting.—The *South Wales Daily News* understands that Mr. Duff-Assheton-Smith has leased Penybryn to Mr. W. H. Preece, whose intention is to have his Welsh home lit up with electric light.

Lane-Fox Patent.—Mr. Lane-Fox yesterday presented a petition before the Judicial Committee of the Privy Council at Whitehall for the prolongation of his patent. We are informed that the petition was refused.

Society of Arts Conversazione.—The Society's annual *Conversazione* was held at the South Kensington Museum (by permission of the Lords of the Committee of Council on Education), on Wednesday evening, 29th June. The number of vistors attending the *Conversazione* was 1,750.

Willesden and Electric Lighting.—The Local Board of this suburb have, at last, come to a definite conclusion with respect to the electric lighting question. Upon the recommendation of the Law and Parliamentary Committee, the Board has decided that their clerk and surveyor shall confer together with a view of taking steps to obtain a provisional order in the ensuing session of Parliament. Judging from the wording of the recommendation it does not appear as if immediate action to supply the light is contemplated.

A New Electrical Journal.—It is stated that a new monthly electrical journal will shortly make its appearance in Chicago, U.S.A.

Institution of Electrical Engineers' Conversazione.—The annual conversazione of the members of this institution was held last Friday in the galleries of the Royal Institute of Painters in Water Colours, Piccadilly. Professor Ayrton and Mrs. Ayrton received the guests, to the number of about 850, who were entertained with an excellent programme of music by the fine band of the Royal Horse Guards under Mr. C. Godfrey.

Singular Phenomenon at Vienna.—A severe thunderstorm passed over Vienna one day last week, says the *Daily News*, and some fears were entertained for the exhibition buildings. No damage was done, but there was an important experience in connection with the electric lighting of the place. The lightning seems to have been attracted by the electric wires, and once, for a moment, all the large Swan lamps throughout the buildings were lit up. The automatic signalling brought out the fire brigade and the theatre was examined from roof to basement.

Cable Translator.—Mr. E. Raymond-Barker, of the Silvertown Telegraph Works, is bringing forward a development of the submarine relay of Mr. Cuttriss. The chief point of difference is the substitution of a liquid resistance for the carbon springs, and the use of a double differential system, whereby it is proposed to attain greater sensitiveness. From what we have seen of this invention, it appears to possess decided advantages, especially in the direction of automatic translation.

Electrical Trade Section.—A meeting of the Electrical Trade Section will be held at the offices of the London Chamber of Commerce, to-day, at 3.30 p.m., to consider the appended agenda, when a full attendance is particularly requested:—Agenda.—(1) Minutes; (2) Report of Special Committee appointed to consider the County Council Bye-Laws on Overhead Wires; (3) Report as to the action taken by the Special Electrical Traction Committee (4) Report of the Special Chicago Exhibition Committee; (5) Standardising of Machinery; (6) Uniformity of prices; (7) Foreign Competition; (8) Other matters.

Relative Proportions in Railway Power Plants.—Such is the title of an article recently published in the *Electrical Engineer*, of New York. It would appear that the relative proportion between dynamo and engine plant is not yet definitely settled, and we can fully understand that this is the case; so much depends on the character of the traffic, the ruling grade and the number of the cars. Mr. Lee Church, an authority on the subject, reasons from the mechanical engineer's point of view, perhaps, and considers that the output of a dynamo is simply a question of heating; and so if the overloading be not for too long a period it may be relatively heavy; but with the engine, the case he considers, is different and there is not such a margin for excessive loads, though an honestly rated engine will stand overloading to the extent of from 20 to 25 per cent. This question, writes Mr. D. D. Book, depends on the type of engine. If single high pressure cylinders be used, the rated output may be largely exceeded for short periods; but with compound engines so large a variation is not possible, owing to the drag of the low pressure cylinder at light loads. Mr. Chas. Hewitt fixes the average output at two-thirds the maximum load with medium size lines, and with small lines of six to a dozen cars at about 50 per cent. Messrs. Crosby and Bell in "The Electric Railway," advise the rated engine capacity to be 75 per cent. of that of the dynamos, the latter being about 50 per cent. of the rated output of the motors, and the boiler power to be sufficient to run the engines at their designed load with a small margin. These seem to be reasonable proportions for medium lines and do not overtax the dynamos, while the momentum of extra heavy flywheels supplies the momentary demands on the engine. But experience alone can answer these questions in a definite manner.

A Useful Publication.—Mr. Ralph W. Pope, the Secretary of the American Institute of Electrical Engineers, has commenced the publication of a monthly, "Digest of Electrical Patents." The digest will embrace a synopsis of each patent taken out relating to electricity granted during each month. The digest should meet with success as it will, no doubt, serve a very useful purpose.

Criticism for the Dissociationists.—There is nothing like taking an attack right into the enemies' camp if you are sure of your forces, and if other things are equal. Mr. S. U. Pickering is evidently of this way of thinking, and has recently published a paper in the *Berichte* (xxv., pp. 1,099—1,107), which will give dissociationists some trouble. He considers the cryoscopic behaviour of weak solutions, and this paper more especially deals with sulphuric acid. He gives a critical examination of his previous results in this much-disputed field of research, and points out that the values calculated according to Van't Hoff's formula and the dissociation hypothesis do not agree within experimental error with the observed values; the total error seems to be very much greater than it should be, and even imagining the existence of some regular, but unknown source of error, the disagreement is still too pronounced. We shall await with interest the remainder of Mr. Pickering's critical examination of results.

BUSINESS NOTICES, &c.

The Electric Lighting at Barnet.—The award in the arbitration between Messrs. H. F. Joel & Co., of 31, Wilson Street, London, and the Barnet Local Board, in which Messrs. Joel claimed compensation for breach of contract, was taken up by Messrs. Joel and Co., on Friday last, June 30th, and was entirely in favour of Messrs. Joel & Co., who obtain £500 as damages, and their costs in the reference, and the costs of the award. The arbitration proceedings were taken by Messrs. Joel & Co. for certain alleged breaches of the contract between themselves and the Barnet Local Board. Messrs. Joel undertook, under somewhat exceptional circumstances, to light the streets of Barnet with the electric light for three years, at a cost, light for light, less than had been paid for gas, and owing to the very short time allowed to do the work, they undertook to fix temporary plant and overhead wires, to be replaced within 12 months by permanent plant and underground wires, the consideration being that the Barnet Local Board were to give them the sole right to supply the private lighting for the three years, and a perpetual, but not a sole right, thereafter to continue so to supply the private lighting. The Barnet Local Board undertook to consent to Messrs. Joel having a license or provisional order, if necessary, to carry out the lighting. Messrs. Joel fitted the street lamps in an exceptionally short time, and started the light on September 1st, 1888, as agreed; but when in the following April the Local Board were asked to give their consent to the application to the Board of Trade for a license, they refused their consent, although just previously they had been urging Messrs. Joel to take the license, and had actually agreed and did call a meeting to give such consent. This refusal completely stopped Messrs. Joel putting their wires underground, and, of course, they were unable to supply the private customers. The overhead wiring was not intended to be other than temporary, but it had to stand for the three years of the contract, and in the first two months of the lighting was the case of several failures, which were much advertised to the prejudice of Messrs. Joel & Co. Messrs. Joel & Co. contended that such refusal of the board to carry out the terms of the contract was a breach of that contract, and towards the end of the three years commenced the arbitration, with the result as first stated. Messrs. Joel & Co. completed their part of the contract to light for three years, in spite of the difficulties and opposition thrown in their way. Mr. John Fell was the arbitrator for Mr. Joel and Mr. Slater for the Barnet Local Board, whilst Mr. Lumley Smith, Q.C., was the umpire, Messrs. Ingledew Ince & Colt representing Mr. Joel, instructed Mr. Robson, Q.C., and Mr. Poole, the solicitor to the Barnet Local Board, instructed Mr. Fletcher Moulton, Q.C., and Mr. Gordon. The arbitration proceedings occupied many days, and many witnesses were examined, amongst them being the the following electrical engineers—Mr. Preece, Mr. Probert, Mr. Howard Swan, Mr. Potter, Mr. Sennett, and most of the members of the Local Board. We understand Messrs. Joel & Co., immediately after taking up the award on June 30th, gave the formal notice to the Barnet Local Board of their intention to apply in the forthcoming session for a provisional order under the Electrical Lighting Acts of 1882 and 1888. Mr. Preece's evidence was to the effect that on the two occasions upon which he saw the electric light at Barnet, "the lighting was everything that could be desired."

Milling Exhibition.—At this Exhibition, which closes to-day (July 8th), perhaps the most striking novelty was the "Chatterton" engine. From the model shown, the engine seems to be a perfect single action steam engine, working in all respects as a steam engine, but, by simply turning a cock, an explosive mixture of gas and air is admitted into the cylinder, and then fired by electricity. At the next stroke steam is again admitted, and so on. First a steam admission, and then air and gas. By a very simple valve arrangement the successive admissions are regulated. The inventor claims that by this engine he uses the defects of the gas engine to cure the defects of the steam engine, and, whilst he obtains all the ease and smoothness of the steam engine, together with its facility in starting and slowing down, he also obtains very nearly the economy of the gas engine, and calculates that large powers may be obtained at the decreased expenditure of 1¼ lbs. of coal per indicated horse-power per hour. It is well known that only 10 per cent. of the heat given out by coal is turned into power by the steam engine, one considerable source of waste being initial condensation caused by the heated steam entering a comparatively cold cylinder. In the gas engine, on the other hand, the difficulty to overcome is the excessive heat generated in the cylinder at each explosion. This is so great that a constant stream of cold water has to be circulated round the cylinder to keep it from getting red hot. What the inventor claims in the "Chatterton" engine is, that this heat, instead of being wasted and carried away by the cold water jacket, is, by the alternate admissions of steam, transferred to another medium, namely, aqueous vapour, which is more suited by its physical constitution to the development of power at lower temperatures. As exhibited at the Royal Agricultural Hall, the engine is only adapted for mills and factories, or electric light stations, for which it furnishes a suitable power at from 50 to 500 I.H.P., and a Dowson gas plant is exhibited as being suitable for manufacturing the gas; but the inventor claims also to use, where gas cannot be conveniently made, a petroleum spray.

Tenders Wanted—Claybury.—The Asylums Committee of the London County Council are prepared to receive tenders for generating plant and principal mains required for the installation of electric light at the London County Lunatic Asylum, in course of erection or completion at Claybury (Woodford), Essex. Printed forms of tender, contract (with specification and schedules annexed) and bond, and lithographed copies of the drawings, can be obtained on application to the Clerk of the Committee, at the offices of the Committee, 40 Craven Street, Strand, on payment of £5, which will be returned on a *bona fide* tender being delivered within the appointed time, or on return of the forms and drawings before that time. Tenders must be on the printed form, and be accompanied by the printed forms of contract, with the schedules thereto and bond, and with the schedule of prices forming the second schedule to the said form of contract, and the schedule of rates of wages and hours of labour, &c., fully priced out and signed, and the whole must be enclosed in a sealed cover, and be delivered at the offices aforesaid of the Committee not later than 12 o'clock at noon on July 26th, 1892. The contractor will be bound by the contract to pay to all workmen employed by him the rates of wages, and to observe the hours of labour and conditions recognised as fair by the several trades unions of the districts in which the work is done, at the date of the delivery of the tender. The contractor will have to enter into a bond in the penal sum of £500, with two approved sureties, each in £250, as security for the due performance of the contract.—R. W. Partridge, Clerk to the Asylums Committee of the London County Council.

Tenders Wanted—Newcastle.—The Committee of the Co-operative Wholesale Society, Limited, are prepared to receive tenders for the electrical lighting of the whole of their warehouses and offices in Waterloo and Thornton Streets, Newcastle-upon-Tyne. Full specification and any other information can be obtained from the society's engineer, Mr. John Thompson, C.E., Post Office Chambers, Newcastle-upon-Tyne. Specifications will be supplied on depositing two guineas, and the amount returned on receipt of priced tender. Tenders are to be delivered at the office of the society on or before July 19th, 1892. The board do not bind themselves to accept the lowest or any tender.

Tenders Wanted — Dublin. — The Corporation of Dublin are prepared to receive, on or before the 8th inst., tenders for running the electric light installation of the city for 12 months. The specification, prepared by Mr. Spencer Harty, city engineer, may be obtained at his office, City Hall, on payment of one guinea, which will be returned to all persons sending in a *bona fide* tender. Tenders to be enclosed in sealed envelope, addressed and forwarded to the Chairman, Electric Light Committee, City Hall, Dublin, and endorsed "Tenders for Running Electric Light Installation."

Tenders Wanted—Cuba.—The Ministerio de Ultramar, in Madrid, is inviting tenders until August 8th for the concession for the erection and working of a telephone system in Mantanzao, in Cuba.

The Bankruptcy of Joseph Slater Lewis.—The public examination in bankruptcy of Joseph Slater Lewis, described as an electrical appliances manufacturers' manager, of Middlesex, and lately carrying on business at the National Telegraph Works, Wainwright Street, Aston, and residing at the Swifts, Yardley, took place at the Birmingham County Court last week before Mr. Registrar Cole. The liabilities were stated at £1,613 18s. 7d., and assets *nil*. After a little discussion, the bankrupt said he desired the matter over as quickly as possible, for certain things were hanging over his head which were acting to his very serious prejudice. Eventually it was decided that the examination should be adjourned until July 25th.

Paterson & Cooper.—A very successful installation of electric lighting has just been completed at Cardean, the country residence of Mr. Edward Cox. The work has been carried out by Messrs. Paterson & Cooper, of London, Glasgow, and Dundee, to the plans and specifications of Mr. W. C. Martin, manager of the firm in Scotland; while Mr. W. A. Wilson, from the London office, superintended the erection and fitting of the installation. The same firm have just completed the fine s.y. *Vanduara* for Mr. Stewart Clark, of Paisley, and also the new steamers, *Dungeness* and *Peregrine*, recently launched in Dundee.

Benham & Froud, Limited.—To celebrate the jubilee of Mr. Froud's connection with the Chandos Metal Works (established in 1785), the chairman invited the directors, and a few other gentlemen immediately connected with the company, to dine at the Cyrstal Palace on the 30th ult., the occasion forming a pleasant termination to the labours of some of their number in connection with the Electrical Exhibition. By a curious coincidence, one of the company's braziers also attains his jubilee of work this month, and the event was fittingly marked by a presentation during the afternoon of the same day.

New Business.—We understand that Mr. Fuller, who for the last two years has had charge of the wiring department of the Brush Company, and Mr. Tate, who for about 2½ years was assistant engineer in the company's estimating department, have severed their connection with the Brush Electrical Engineering Company. These two gentlemen are commencing business under the name of Fuller and Tate, as electrical and mechanical engineers, at 20, Bucklersbury, E.C. Business will be started about 11th inst.

Electric Launches.—The *Florentia*, an electric launch, had her trial trip at Twickenham last Friday. The motor, which has been specially designed for this boat, gave very excellent results. The current was supplied from 24 accumulators, Electrical Power Storage Company's T-type in teak boxes, 19 plate, 1 to 40 ampères discharge. The launch left Mr. Sargeant's electric launch works at Twickenham, for Caversham Park, Reading, the residence of her owner, W. T. Crawshay, Esq., and accomplished the run with two charges. During Henley Regatta there were a large number of electric launches exhibited. The Thames Electric and Steam Launch Company have now on hand a large number of orders for launches, which will be laid down on completion of the new works at Twickenham.

Country House Lighting.—Messrs. Drake & Gorham are exceptionally busy in this branch of electric lighting. They have obtained the contract for an installation at Captain Hatfeild's house, Hartsdown, near Margate, where the plant will be driven by an existing steam engine. Among other installations this firm are carrying out, may be mentioned Buchanan Castle, for the Duke of Montrose, and Elmfield, Harrow, for the Rev. H. A. Davidson.

The Electric Light in the North-West and West Districts of London.—Messrs. Hunter & Oliver, of 67, Tottenham Court Road, are fitting up an installation of the electric light at 66, Gloucester Gardens, N.W.—Messrs. Lund Bros. & Co., 335, Oxford Street, are fitting up an installation on the premises of Mr. David Stott, 370, Oxford Street, W.

H. F. Joel & Company.—This firm is at present exceptionally busy. Messrs. Joel recently received orders for three 60-unit dynamo machines, with three similar machines to follow, and they have also installation work in hand for over 1,500 lights.

Colliery Electric Lighting.—The General Electric Power and Traction Company, Limited, have received instructions to light the New Hemsworth Colliery, near Halifax. The plant consists of a 300-light dynamo, and the necessary wiring and fittings.

Personal.—We are informed that Mr. D. Sinclair has been appointed engineer-in-chief to the National Telephone Company.

Caution.—We would emphasise our caution of last week against the attempted frauds emanating from certain persons in Holland.

CITY NOTES.

India-Rubber, Gutta-Percha and Telegraph Works Company, Limited.

THE half-yearly general meeting of this company was held yesterday at Cannon Street Hotel, Mr. S. W. Silver presiding.

The SECRETARY (Mr. Tyler) having read the notice convening the meeting,

The CHAIRMAN said: I rise to move that an interim dividend of 5 per cent., or 10s. per share, free of income tax, payable on or after the 8th inst., be now declared, and I may mention that the account of our general sales is increasing, that the additional capital referred to on our last occasion of meeting was readily taken up, and that our position is much strengthened in consequence. We have manufactured and despatched the cable that was then also referred to. Our steamer, *Silvertown*, is now off the coast of Brazil, engaged in laying the cables across the Atlantic to the West Coast of Africa. The works, buildings, and machinery are in excellent order. We are in a position to meet any demand that may be made. I think that completes all the business that I have to bring before you, having moved that an interim dividend of 5 per cent., or 10s. per share, be declared.

Mr. MATTHEW GRAY (managing director) seconded the resolution, which was unanimously carried.

A vote of thanks to the chairman and directors having been replied to by Mr. SILVER, the proceedings terminated.

Hobart Tramways Company, Limited.

THE first ordinary general meeting of this company was held at the offices of the company, College Hill Chambers, Cannon Street, E.C., last week, Sir Edward Braddon, K.C.M.G., presiding.

In the course of his remarks the CHAIRMAN said that of the share capital, 45,000 shares had been placed in Tasmania, and 15,000 shares had been reserved in accordance with an agreement. As to the mode of working, they had decided upon using overhead electrical power, which was not only the best, but, as they believed, the cheapest method. As to the working expenses, terms of a very favourable character have been made with the eminent firm of Messrs. Siemens Bros. & Co., Limited, to whom the work of equipping and carrying on the line during the first 12 months had been entrusted. He made some lengthy remarks regarding the financial position of Hobart, and the outlook and prospects in Tasmania generally.

National Telephone Company, Limited.

THE directors' report for the year ending April 30th, states that the income amounted to £463,741, as compared with £431,112. The working expenses and other charges (excluding debenture and other interest), amounted to £236,252, an increase of £36,768. The net result for the year, after deducting the Post Office royalties amounting to £40,239, is a profit of £187,249, a decrease of £7,797. It must, however, be remembered that at the end of 1890, in view of the expiration of important patents, a reduction of the tariffs in most of the company's districts was carried into effect. Upon the business of the past year, this reduction has been equivalent to a cession of about £55,000 to the subscribers. Further attention may be called to the fact that the rentals carried forward this year for unexpired terms of running contracts amount to £234,370, an increase of £29,938. Out of the divisible balance, after providing for interest on debenture stock, an interim dividend for the first half-year has already been paid at the rate of 6 per cent. per annum on the first and second preference shares, and 5 per cent. per annum on the ordinary shares. The board recommend a further dividend for the last half-year at the rate of 6 per cent. per annum on the first and second preference shares, and 7 per cent. per annum on the ordinary shares, making, with the interim dividend, 6 per cent. for the year. They propose to transfer to reserve account £10,000, which, with £1,127 placed to reserve during the year from premium account, will bring up the amount of the reserve fund to £104,627.

The Edison and Swan United Electric Light Company, Limited.—At a board meeting, held last Tuesday, it was resolved:—"That, subject to audit, the shareholders be recommended to declare a dividend on the A shares of the company, of 5s. 8¾d. per share on the 89,261 ordinary shares £3 paid; of 9s. 6½d. per share on the 5,000 £5 fully paid shares allotted to the Edison Electric Light Company, Limited; and of 8s. 10¾d. per share on the 12,139 £5 fully paid shares allotted to the Swan United Electric Light Company, Limited, free of income tax, being, with the interim dividend paid on February 22nd, 1892, 7 per cent. in respect of the year ending June 30th, 1892; 7 per cent. in payment of arrears of cumulative preferential dividend for the year ending June 30th, 1887; and of 4 per cent. in respect of the year ending June 30th, 1888; all to be distributed in accordance with the provisions of clause 87 of the articles of association."

Stock Exchange Settlements.—Application has been made to the Stock Exchange Committee (1) to appoint a special settling day in, and to grant a quotation to the Metropolitan Electric Supply Company, Limited—£50,000 5 per cent. registered debentures. (2) To appoint a special settling day in Woodhouse & Rawson United, Limited—Further issue of shares; ordinary, Nos. 90,001 to 105,200; preference, Nos. 70,001 to 81,088. (3) To allow the following security to be quoted in the official list:—Elmore's Patent Copper Depositing Company, Limited—12,395 additional shares, Nos. 70,001 to 82,395.

Eastern Telegraph Company, Limited.—The Eastern Telegraph Company announce that, subject to final audit, the accounts show, after placing about £68,000 to reserve fund, a balance available sufficient to pay at the general meeting, on July 22nd next, the fixed dividend of 3s. per share, being at the rate of 6 per cent. per annum on the preference shares, less income tax; and a final payment of 2s. 6d. per share, with a bonus of 3s. per share, both free of income tax, on the ordinary shares, making, with previous payments on account, a total distribution of 6½ per cent. on those shares for the year ended March 31st, 1892.

Telegraph Construction and Maintenance Company.—An interim distribution of 12s. per share has been announced.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending July 3rd showed an increase of £44.

The Cuba Submarine Telegraph Company, Limited. The estimated traffic receipts of the Cuba Submarine Telegraph Company, Limited, for the month of June, were £3,400, as compared with £3,509 in the corresponding month of last year.

Direct Spanish Telegraph Company, Limited. The receipts for the month of June show an increase of £84, as compared with the corresponding period of last year.

The Eastern Telegraph Company, Limited. The traffic receipts for the month of June were £52,173, as against £52,341 in the corresponding period of last year.

The Eastern Extension, Australasia, and China Telegraph Company, Limited. The traffic receipts for the month of June were £41,738, against £39,749 in the corresponding period of last year; increase, £1,989.

The Great Northern Telegraph Company. Receipts in June 1892, were £24,000. 1st January—30th June, 1892, £128,800; corresponding months, 1891, £141,400; corresponding months 1890, £130,400.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending July 1st, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, amounted to £2,701.

The West India and Panama Telegraph Company. The receipts for the two weeks ended June 30th show a decrease of £61 as compared with the corresponding period of last year.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.	Closing Quotation, June 30th.	Closing Quotation, July 7th.	Business done during week ending July 7th, 1892. Highest.	Lowest.
250,000£	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	101 —104	99 —103xd	101⅜	...
1,300,980£	Anglo-American Telegraph, Limited	Stock	48 — 49	48 — 49	...	...
2,849,510£	Do. do. 6 p. c. Preferred	Stock	88 — 89	88 — 89	88⅝	88¼
2,849,510£	Do. do. Deferred	Stock	10⅜— 11¼	10⅜— 11¼	10¼	...
130,000	Brazilian Submarine Telegraph, Limited	10	10¼— 10⅜xd	10¼— 10⅜xd	10⅝	10⅜
53,200£	Do. do. 5 p. c. Bonds	100	101 —104	101 —104	103⅜	...
75,000£	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107xd	103 —107xd	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2⅞— 3⅛	2⅞— 3⅛	3 1/16	2 15/16
69,996	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛— 2⅜	2⅛— 2⅜	2⅜	2¼
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3¼— 4½	3¼— 4½	...	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	2½— 3½	2½— 3½	...	...
30,152	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152, £4 paid	10	10⅛— 10⅜	10 — 10⅛	10¼	10⅜
$7,716,000	Commercial Cable, Capital Stock	$100	155 —160	155 —160	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	3/16— 3/8	3/16— 3/8	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5½— 6	5½— 6	...	...
16,000	Cuba Telegraph, Limited	10	11 — 12	11 — 12	11⅜	...
6,000	Do. do. 10 p. c. Preference	10	16½— 17½	16½— 17½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3⅛— 3⅜	3⅛— 3⅜	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅜— 11⅝	11⅜— 11⅝	11 9/16	...
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅜— 15	14⅜— 15	15	14 11/16
70,000	Do. 6 p. c. Preference	10	15¼— 15⅜	15¼— 15⅜	15⅜	15 5/16
200,000£	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	108 —111	108 —111	...	...
1,200,000£	Do. 4 p. c. Mortgage Debenture Stock	Stock	108 —111	108 —111	110¼	110
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15 — 15¼	15 — 15¼	15 3/16	15
78,300£	{ Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 }	100	104 —107	101 —104xd	...	...
276,200£	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	104 —107	101 —104xd	103½	...
320,000£	Do. 4 p. c. Debenture Stock	Stock	108 —111	108 —111	...	...
135,000£	{ Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343 }	100	103 —106	100 —103xd	...	...
180,400£	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	103 —106	100 —103xd	101⅜	...
201,600£	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	102 —105	102 —105	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	5½— 5⅝	4⅝— 5½	5⅛	4⅞
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1⅜— 1⅝	1⅜— 1⅝	1 9/16	...
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2⅜— 2⅝	2⅜— 2⅝	2⅝	2⅜
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1⅛— 1⅜	1⅛— 1⅜	1 1/16	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	10⅛— 10⅜	10⅛— 10⅜	10⅜	10 1/16
180,042	Do. do. 6 p. c. Preference	10	15⅛— 15⅜	15⅛— 15⅜	15⅜	15⅛
150,000	Great Northern Tel. Company of Copenhagen	10	18⅜— 19¼	18½— 19xd	18 13/16	18 9/16
220,000£	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	106 —109	106 —109	...	...
12,134£	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	7⅜— 8½	7⅜— 8½	...	...
9,600£	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½— 10½	9½— 10½xd	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	20 — 21	20¼— 21½	21¼	20⅝
200,000£	Do. do. 4½ p. c., Deb., 1896	100	104 —106	104 —106	...	...
17,000	Indo-European Telegraph, Limited	25	40 — 42	40 — 42	41½	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000 ..	10	3½— 4½	3½— 4½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ..	10	8 — 9	6½— 7½	...	...
30,000	†Liverpool Electric Supply, £3 paid	5	3 1/16— 3 3/16	3 1/16— 3 3/16	3⅛	3⅛
10,000	Do. do. fully paid	5	5 1/16— 5 3/16	5 1/16— 5 3/16	5⅛	4⅞
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000£	Do. do. do. 6 p. c. Debentures	100	107 —110	107 —110	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6½— 7	6½— 7	6 9/16	...
447,234	National Telephone, Limited, Nos. 1. to 438,984	5	4⅞— 5⅛	4⅞— 5⅛	5 1/16	5
15,000	Do. 6 p. c. Cum., 1st Preference	10	13⅜— 14¼	13⅜— 14¼	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	12⅜— 13¼	12⅜— 13¼	13¼	...
420,000£	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	107 —109xd	108 —110xd	109⅛	108 1/16
250,000£	Do. (issued at 5 p.m., all paid)	...	104 —107xd	108 —110xd	108½	...
6,318	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	4 — 5	4 — 5	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16— 5/16	3/16— 5/16	...	...
9,000	Reuter's Limited	8	7 — 8	7 — 8	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8⅛— 8⅜	8 — 8⅛	8⅜	...
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	7⅞— 8¼	8 — 8⅛	...	...
3,381	Submarine Cables Trust	Cert.	115 —120	115 —120	116½	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3¼— 3⅜	3¼— 3⅜	3 7/16	3 5/16
37,350	Telegraph Construction and Maintenance, Limited	12	45 — 47	45 — 47	45½	45
150,000£	Do do. do. 5 p. c. Bonds, red. 1894	100	103 —106	103 —106xd	...	...
58,000	United River Plate Telephone, Limited	5	1½— 2½	1½— 2½	...	...
146,370£	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95xd	85 — 95xd	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	7 — 8	6 — 8	...	...
271,400£	Do. do. do. 5 p. c. Debentures	100	100 —103	100 —103	...	...
30,000	West Coast of America Telegraph, Limited	10	3½— 4½	3½— 4½	3⅜	...
150,000£	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	101 —105xd	101 —105xd	...	...
67,007	Western and Brazilian Telegraph, Limited	15	8⅜— 9½	8⅜— 9½	8⅜	...
30,364	Do. do. do. 5 p. c. Cum. Preferred	7½	6 — 6½	6 — 6½	...	...
30,364	Do. do. do. 5 p. c. Deferred	7½	2⅜— 3¼	2⅜— 3¼	...	...
189,700£	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	105 —108	105 —108	...	...
237,200£	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	105 —108	105 —108	...	...
88,321	West India and Panama Telegraph, Limited	10	1½— 1⅝	1½— 1½	...	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	9½— 10	9½— 10	9⅞	9½
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8 — 9	8 — 9	...	...
80,000£	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	102 —106xd	102 —106xd	...	...
$1,536,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	118 —122	118 —122	...	...
173,100£	Do. do. 6 p. c. Sterling Bonds	100	100 —103	100 —103	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	6¼— 6⅜	6¼— 6⅜	6½	6 9/16

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid 7½—7⅝.—Electric and General Investment, shares of £5 (£1 paid), 2⅜—3½.—Founders' shares, 200—225.—Elmore Foreign and Colonial Copper, Founders shares, 6½—7½.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20½.—Founders' shares, 10—20.—Halifax and Bermuda Cable 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 2½—3½.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅜—6, 1st Preference Cumulative 6 per cent., £5 (fully paid), 5¼—6.—Liverpool Electric Supply Shares of £5 (fully paid), 5 1/16—5 3/16.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—¼.—Metropolitan Electric Supply Company, Founders' Shares, 50—150.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid), 10—¼.—Do. 4½ per cent. preference shares of £10 (fully paid), 10—¼.—Do. Debentures, 103—¼.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), ⅛—¼.—£5 Preference (fully paid), 2½—3.—Ward's Electric Car (£10 paid), 1⅛—1⅜.

BANK RATE OF DISCOUNT.—2 per cent. (April 28th, 1892).

ELECTRIC RAILWAYS FOR LONDON.

BAKER STREET AND WATERLOO SCHEME.

A SPECIAL Committee, appointed by the Chairman of Committees in the House of Lords, on Thursday, June 23rd, commenced sitting to consider the schemes passed by the House of Commons for the construction of electric railways from Baker Street to Waterloo, and from the Finsbury Park station of the Great Northern Railway to Moorgate Street. The committee were the Marquis of Waterford (the chairman), the Marquis of Breadalbane, Lord Magheramorne, Lord Norton and Lord Wimborne. There were three petitioners against the former scheme—the Metropolitan and the South-Eastern Railway Companies, and the London County Council. Against the second scheme the petitioners were the Metropolitan and the City and South London Railway Companies, the owners of the Union Chapel, Islington, and Messrs. J. E. Brown and others.

The CHAIRMAN, in opening the proceedings, pointed out the desirability of the counsel being as brief as possible, as the time at the disposal of the committee was limited.

Mr. PEMBER, Q.C. (who, with Mr. Cripps), appeared on behalf of the promoters of the Baker Street and Waterloo Bill, stated that the line would be very different to the ordinary underground railways. Each railway would be constructed in two tunnels for separate up and down traffic, and would be approached by means of inclines, stairs, or hydraulic or other lifts. The company was to be at liberty to construct and work a generating station and engine for the production of electricity, and the traffic on the railways was to be worked by electricity or cable power. Mr. Pember proceeded to quote statistics as to the enormous growth of traffic both at Waterloo and at Baker Street, much of which he said would be benefited by the accommodation which the proposed new line would afford.

The CHAIRMAN: Counsel need not dwell upon the quantity of traffic—that is perfectly clear.

Mr. PEMBER added that that enormous traffic gave good prospects of the success of the line. He then alluded to various provisions of the Bill, one of which was intended specially for the protection of the Postmaster-General, by so constructing the lines and works, and working the railways, as to prevent any interference with the Post Office telegraphic lines. A somewhat similar provision was in the Bill for the protection of the National Telephone Company, Limited. The scheme, he said, was alleged by the opponents to be an imperfect one; but he would be able to show that that was not a very serious objection. The Metropolitan Railway Company took exception to the motive power, and in their petition they said:—"Moreover, your petitioners submit that the working of the proposed railways cannot be effectually accomplished by electricity as a motive power. The application of electricity as a motive power on railways is at present in its infancy, and although experiments have been made, the practical results have been uncertain and unsatisfactory, and will be inadequate as a sole means of efficiently working a line of railway such as is proposed by the Bill. Your petitioners are advised that the cost of working railways or subways by electricity is proportionately very much greater than the cost of the ordinary method of working the traffic on railways, and that although it is true that the City and South London Railway has been worked since its opening by electricity, such working has been frequently unreliable, and it will be found that the cost is too great to prevent all railways worked by this system, even although they carry an enormous metropolitan traffic, which your petitioners deny would occur in the present case, being commercially unremunerative concerns. Your petitioners submit that the promoters of the Bill have inserted this provision in Clause 8 of the Bill, in order to secure for the Bill a measure of public favour, and to facilitate its passing into law, and that the probability is that in the event of the Bill being sanctioned, the promoters having obtained powers for the construction of their railway, will go to Parliament in a future session for power to make use of steam, which is the only motive power which at present could, with efficiency and economy, be used upon railways." Mr. Pember contended that any new underground railway should not, as the opponents urged, be of the ordinary character. Such new line ought not to be productive of smoke and deleterious gas, nor have any blow-holes. As to the objection which the Metropolitan Company took on financial grounds, he contended that they had nothing whatever to do with that question. The opposition of the South-Eastern Company he looked upon as not very serious.

Sir J. WHITTAKER ELLIS, Bart., M.P., was examined by Mr. Cripps, and said that for the last 40 years he had been a traveller on the South-Western line, the traffic on which had increased so much lately, that there was now great difficulty in getting from the station to other parts of London. In the public interest the proposed new electric line to Baker Street would be a great advantage. It was most difficult now to get from North to South London, and from east to west. Between Charing Cross and Oxford Street the new line would have a large pick-up traffic, and it would be a great benefit to the St. John's Wood district. There was now delay and inconvenience in getting from Hampstead to the West End, and the proposed line would be a great public service, and would gather an enormous traffic, not only from north to south, but also south to north throughout the day. The Metropolitan line was altogether outside the proposed route.

Mr. JAMES HENRY GREATHEAD, engineer of the suggested railway, and also of the City and South London Electric Railway, stated that he had had large experience in the construction of railways, especially of the system of underground railways by tunnels. He carried out the electric railway from the Monument to Stockwell. That was effected without doing any material injury to any of the houses or property on the route. The object of the proposed new line was to give a through communication from Waterloo to Baker Street, and from Baker Street to Waterloo, and also to do a pick-up traffic at the various stations. It would accommodate the large traffic at the existing stations. The first station of the new line would be at Charing Cross, another would be at Piccadilly Circus, to the site of which no objection was taken, and there would also be one at Baker Street. There would be no difficulty in respect of either curves or gradients. There were both curves and gradients on the South London Electric line. The speed of carrying the traffic would be on an average 18 miles an hour, including stoppages. On the Metropolitan Inner Circle line the average speed was little more than 11 miles an hour. There was no question whatever about the speed. The dip for the tunnelling would be on the south side of Waterloo Station, and that dip would be common to the two lines if the Waterloo and City railway scheme was also approved. In answer to the chairman, the witness said that the depth along the route would vary from about 50 to 85 feet.

The CHAIRMAN: There is another question I should like to ask you. You talk about gradients. What is the necessity of gradients if you are boring through the ground? Is it to get it up to the level of the top of the ground?

The WITNESS: The object is to avoid having the depth greater than is absolutely necessary at the stations, and particularly at the terminal stations where we should probably have to exchange traffic.

What is the minimum depth throughout the line, because that would have a serious effect with regard to the house property? The minimum depth on the north side of the Thames is a little over 50 feet, and the maximum is 85 feet on the south side of the Thames, where we come nearer to the surface in order to reduce the distance between our platform and that of the other company.

Mr. CRIPPS: Everyone is now satisfied with regard to the depth, and there is no opposition?—Yes.

Would there be any, the smallest risk, to any house property along the route?—No; the works could be carried out with perfect safety.

Replying further to the committee, the witness stated that the minimum speed of the electric train would be about 30 miles an hour. There would be a diameter of 11 feet for the permanent iron tunnels. Having elaborately explained the system of boring for the purpose of making the tunnel, Mr. Greathead said that the system was no longer any question of experiment, as it was being carried out at the Clyde and at Kingston, and had been successfully worked at other places. With his present knowledge and experience, he was able to state that there would be no interference with the surface, nor with any buildings. They proposed to use carriages similar to Pullman's cars, with the engines at the end, so as to give more room in the carriages. They would be similar to those used in the elevated railways in New York, where they had found them most convenient, and where the stoppages at the stations were less than those at the Metropolitan.

Mr. CRIPPS: How do you propose to apply electricity as your motive power?—In this case the electricity is proposed to be applied in the shape of the electric locomotives, at the end of the train. They will be separate and distinct as on the South London line.

Would you use the same kind of engines as on the City and South London line?—Yes; only with greater power, so as to enable the train to carry more passengers.

As regards the use of electricity as a motive power, would there, with ordinary care, be any difficulty?—I think it is obvious there would not be. You could get over any difficulty by using more powerful locomotives, and if you had a train twice as heavy as on the South London line, you could have two locomotives to draw it. There is no difficulty in designing locomotives to do whatever work may be required.

On the South London line the proposed electric power would carry trains of the ordinary size and weight?—Yes; those trains would weigh about 280 tons, and these would be about 120 tons.

You do not propose to make any shafts or blow-holes anywhere?—No; the ventilation will be obtained by having two separate tunnels, and the trains in moving through these tunnels will act as pistons, and force a considerable proportion of air in front of them forward as they approach the station, and the air will come out at the stations from the shaft. Then, as the trains leave the station, they similarly suck in behind them air from the shafts, and therefore you get a current of air always in the same direction, and that current is sufficient to accomplish the ventilation of the tunnel. On the South London line the ventilation is perfect, and the air there is as good as it is outside.

The CHAIRMAN: You say the ventilation is perfect?—Yes.

What is the size of the tunnel?—It is 10 feet at the City and 10 feet 6 inches at the other end.

And you are going to make this one larger?—Yes.

It is one train running always one way that keeps the tunnel clear.

The WITNESS then said that he was responsible as engineer for the estimated cost of constructing the proposed line, and the estimate was an ample one. The estimated number of passengers which would be carried was 15,000,000, and carried at an average of a little less than 2d. a mile, it would pay the working expenses, and return 4 per cent. on the whole of the capital.

Mr. PEMBER, at this stage, asked their Lordships to sanction a short adjournment, as he believed that by so doing an arrangement could be come to which would greatly shorten the proceedings.

The committee acceded to the request, and upon resuming, after the adjournment,

Mr. PEMBER said that in the main they had agreed with both railway companies, but there were certain engineering points still open between the promoters and the Metropolitan Company, and those points they would ask their Lordships to determine. To a certain extent his clients were ready to make concessions, and they could fight out the open points on the clauses. He would therefore ask the committee that the Bill might proceed, leaving the disputed questions open. With regard to both the companies, the promoters had agreed,

inasmuch as the report of the joint committee was to the effect that that proposed railway, or railways like it, were not incompatible with the through line of communication. They were perfectly ready to submit to a clause to the effect that they would not oppose any Bill, except to protect their own line, which the Metropolitan or the South-Eastern might propose, on the understanding that it would be of the ordinary character.

The CHAIRMAN then asked, with regard to the safety of the public, whether the line was to be worked on the block system or not.

Mr. PEMBER: Certainly, my Lord. He then said that there was no more evidence on the preamble, which was agreed to by the committee.

Upon considering the clauses of the Bill, Mr. TAYLOR (counsel for the Metropolitan Railway) took exception to the proposals for constructing the line at Baker Street, on the ground that his clients would be seriously prejudiced in future works which they had in contemplation, because the line would not be sufficiently deep.

Sir BENJAMIN BAKER was called in support of this contention, and said there was no valid reason why the new line at Baker Street should not be at least 15 feet lower than was contemplated. In connection with the terminus of the Manchester, Sheffield and Lincolnshire Railway, several millions of money might have to be expended at Baker Street, and that company ought not to be prejudiced for a little electric omnibus line like the one proposed.

Mr. PEMBER: Oh! it is all very well for you to express your contempt; but we shall spend a million of money.

Mr. GALBRAITH, on behalf of the promoters, stated that he thought it rather unfair that this objection as to the depth of the line at Baker Street was not raised when he was in consultation with the Metropolitan Company, and that it was left to be sprung upon them in committee. If they were forced to go down 15 feet more, it would be very inconvenient to the passengers, who would have to be brought up from the railway part of the way in a lift, and then get out and go the remainder of the distance to the street by a staircase. By the proposed scheme the petitioners would not be at all seriously affected.

The sitting was then adjourned until Friday.

Upon resuming on Friday,

Mr. WORSLEY TAYLOR, Q.C., continued his speech interrupted on the previous evening, when he was dealing with certain suggested alterations to clauses in the Bill. He said it was absolutely necessary, in the interests of the Metropolitan Company, that it should retain in its own possession the under-story of its lines at Baker Street. The question was whether the company was to retain its rights over its own property, or not—property which it needed for the future development of the railway. After the evidence of Sir Benjamin Baker on the previous day, there was no objection to lifts; and it did not much matter whether they went down 10 or 60 feet, if lifts were used at all.

Mr. GALBRAITH, recalled, said that besides lifts there would be stairs by which to reach the underground stations, but the lifts chiefly would be used.

Mr. TAYLOR said he hoped the committee would not put any difficulties in the way of the main line companies securing communications north and south through London. The proposed shuttle line would pass under the Metropolitan lines, and if that was permitted it would be a serious interference with them in alterations which they might wish to carry out in the future.

The room was then cleared, and on the public being re-admitted,

The CHAIRMAN said the committee had considered the question very carefully, and had come to the conclusion that the objection raised to the clause in its present form was legitimate, and therefore they agreed to insert in the clause the figures suggested by Sir B. Baker, so that the electric railway at Baker Street must be put down 15 feet lower than the promoters wished. The committee were almost unanimous in feeling that there was some doubt as to the ventilation of the railway. He was informed that in the present electric railway—the South London—the ventilation was not very good, and he would like to ask the learned counsel whether the ventilation shafts proposed would be quite independent of the lift shafts, and whether any considerable number of passengers would be in the ventilation shaft at any time. As he understood it, the railway was to ventilate itself on the principle of a piston, a very excellent plan; but if so, the air must be pure. The committee desired to know how it was to be done.

Mr. PEMBER replied that he would prefer that Mr. Greathead or Mr. Galbraith should inform the committee on the point. He believed the air shafts were very large in the present case—40 feet wide in some places, and very much larger than what existed on the City and South London line now at work. The tube of the railway also would be very much larger, so that there would be less difficulty in carrying out the work.

Mr. GALBRAITH, with the aid of a plan, explained to their Lordships the means of ventilation proposed, and said they would arrange for additional ventilation if the committee desired it.

The CHAIRMAN said that, in that case, it would be satisfactory. He believed it did not matter whether the line between the ventilators were a mile or three miles in length, if the ventilation was to be worked on the principle of the piston. If the words needed were put into the clause, the committee would be satisfied.

The promoters and the opposers having settled their differences, and alterations in the clauses to provide for better ventilation having been inserted, the committee passed the Bill, which was sent to the House of Lords for third reading.

THE GREAT NORTHERN AND CITY RAILWAY.

A Special Committee of the House of Lords, under the chairmanship of Lord Poltimore, met on Friday to consider the proposed Great Northern and City Electric Railway, from Finsbury Park to Moorgate Street. Mr. Cripps, Q.C., Mr. Moon, and Mr. Tyrrell were for the promoters of the Bill, and Mr. Worsley Taylor and Mr. Freeman were for the Metropolitan. Messrs. John Edwin Brown and others opposed, not the preamble, but certain clauses, Mr. Arnold Statham appearing for them.

Mr. GREATHEAD, who was the first witness called, practically repeated the evidence given by him before the committee of the other House, saying the estimated cost of the line was £1,500,000.

Mr. MOON submitted the report of the Joint Committee of both Houses on the question of the practicability of working the line by electricity, and said, under the circumstances, he did not know whether the committee would require evidence on the subject or not. If they did he would call Mr. Siemens.

The CHAIRMAN said the committee were satisfied on the subject, so that they would not require such evidence.

Sir ALBERT ROLLIT, M.P., stated that at Islington there was a very strong feeling in favour of the present scheme. Two or three years ago it was his duty to introduce a deputation to the directors of the Great Northern Railway, which deputation asked the company to make a line of the kind to meet the wants of the locality. The directors replied that while they sympathised with the deputation very much, they were quite unable to do as desired. The necessity for the line had been felt in this district for several years. The district was a much overcrowded one.

Local evidence was then called in proof of the necessity that existed for improved travelling accommodation.

Mr. HUGH ROBINSON having given evidence as to the wants of the district,

Mr. JAMES PATTON BARBER, C.E., surveyor to the Islington Vestry, said he appeared before the committee with the authority of the Vestry, and in favour of the Bill. The Vestry were of opinion that to the district of Drayton Park, and other localities in that direction, the railway would be a great benefit. At present, there was no accommodation nearer than Highbury Station. The Vestry had had pressure placed upon them several times to induce them to approach the Great Northern Railway Company with the object of having a new line made in the district, and the feeling of the whole of Islington was, he was certain, strongly in favour of this scheme. The necessity for some such extra means of travelling had been felt for years.

Sir HENRY OAKLEY said he was the general manager of the Great Northern Railway, and that the present scheme was first brought to the notice of his directors in October last, when it was quite a different thing—a small electric railway, with no exchange station at Finsbury Park, as it now had. His directors induced the promoters of the scheme to make it sufficiently large to take in the Great Northern Railway stock, so that the two companies could exchange with each other. The traffic was congested in the busy parts of the day in the district through which the new line would pass. Both in the morning and in the evening time was the object, so that carriages must go through from point to point, from starting to destination. The proposed line would open up a very thickly populated district which had no direct railway communication at present, and would bring a large working population in the neighbourhood into communication with the North. There was nothing more remarkable than the development of the workmen's train service. The Great Northern had only had this sort of suburban traffic for a few years, and they now carried over two million passengers a year. In the early morning they carried this class of passengers for a farthing a mile, and a little later, up to 8.30 o'clock, the rate of fare was a half-penny a mile.

Mr. CRIPPS: I believe the County Council have given your company a very good character in this matter?

WITNESS: Yes; that is one of the good qualities of the County Council. (Laughter.) They are able to appreciate what we have done in the matter of cheap trains. Between 8 and 10 in the morning, and earlier, every compartment of our trains running into the City is overfull, and we cannot deal properly with the traffic. The result is, we receive remonstrances every day from people dissatisfied with the accommodation they get. We have recently spent over £600,000 to give an additional tunnel at King's Cross to assist in meeting the pressure, and we have done all we can. We have had several lines, of the ordinary size, surveyed, with the object of getting further into the City. One of them was along part of this very *route*, but, as the estimated cost of the lowest was three millions, we found it too expensive. I think the present line, if carried out, will assist the Great Northern Railway, and, in addition, nearly earn its own living by dealing with the local traffic. Of course, by going deep underground it will reduce the cost of construction and the amount of compensation to a minimum. There will be no interference with our agreements with the Metropolitan, nor will the profits of the latter be affected to its disadvantage. There will be such a large increase of traffic; it is sure to benefit the Metropolitan as well as the other lines. It is possible that the Metropolitan receipts may go down a little at first, but in the end they will, I think, be benefited. This scheme is not a Great Northern proposal, but we favour it and think it will be a great boon to the people; and if the company can show that they can successfully work it by electrical means, and can do so with certainty, we shall be glad to run our trains over the line. All we want is to open up our district. We pay to the Metropolitan for the use of their lines, £24,000 a year; the minimum we can pay them under our agreements is £14,000 a year. At present we run 70 or 80 trains per day, each way, over the Metropolitan. In my opinion the necessity for better railway accommodation in the northern part of London is rapidly becoming a public scandal.

In answer to the CHAIRMAN, WITNESS said the overcrowding of trains mentioned by him was an element of danger, though not perhaps, an actual danger to life and limb, because the trains were not started till the people were clear of them. Nothing was more remarkable than the manner in which improved means of travelling

caused an increase in the amount of traffic. He did not think it would be actually dangerous to increase the number of trains run on the Metropolitan, for with the present methods of signalling, and the present block system, accidents were impossible, unless a man failed altogether.

Mr. WORSLEY TAYLOR, addressing the committee at the close of the evidence, said he asked them not to sanction the preamble of the Bill unless something were inserted in the shape of a clause to safeguard the interests of his clients, the Metropolitan. If the new line became a reality it would very seriously compete with the existing Metropolitan, which was already in a difficult enough position, as the committee were fully aware, and although the Great Northern Railway were under an agreement to use the Metropolitan lines, there would be nothing to prevent them from transferring their traffic from the latter to the new railway.

After a short consultation in private, the committee arrived at the unanimous opinion that the petitioners against the Bill had not proved their case, and that the preamble had been proved.

Some minor alterations were then made in several of the clauses, after which the Bill was remitted for third reading.

CENTRAL LONDON AND LIVERPOOL STREET EXTENSION.—NO OPPOSITION.

Before the Lord's Committee, over which Lord Poltimore presided on Friday, June 24th, the Central London and Liverpool Street Extension Electrical Railway came up as a practically unopposed measure, and was passed, making three schemes carried out of the six introduced during the session. The only petition against the third reading in the House of Lords was by Mr. Morris Powell, a house owner at Kensington, who opposed in both Houses last year. The substance of his petition appeared to be that although the Central London Railway was sanctioned in 1891 to carry a certain number of passengers, he apprehended that the extension to Liverpool Street would lead to the carriage by the railway company of many persons through *his* subsoil to his detriment, notwithstanding that the tunnel or tube will be 50 or 60 feet below the surface. There being no other opponent, Mr. Powell did not press his opposition.

The three remaining Bills are laid aside till the opening of a new Parliament.

LEGAL.

Lane-Fox v. The Kensington and Knightsbridge Electric Lighting Company, Limited.

(*Continued from page* 26.)

WE continue from our last issue the arguments in this appeal by the plaintiff in person to Lords Justices Lindley, Lopes and Kay from the judgment delivered on the trial of the action in March last, bearing upon an alleged infringement of plaintiff's letters patent in electric lighting.

Continuing his address on Wednesday, last week (when the other business before the Court lasted until the afternoon), Mr. WALLACE called attention to the evidence on the charging and discharging of the batteries, with the object of showing what was done in that matter. It was considered by some of the witnesses, and for a long time was in the minds of the judge and of certain witnesses on the other side, that the plateau of discharge was the same as the plateau of the charge; but that theory had vanished.

Mr. LANE-FOX (interposing) said he thought as none of this was disputed it was irrelevant, and some discussion arising on this point, Mr. Lane-Fox said he admitted it took 110 volts to charge up, but he urged it was not necessary to have the batteries so charged, in order to keep the pressure in the main.

Mr. WALLACE thereupon directed his attention to this point of difference, quoting thereon the evidence of Mr. Drake, Mr. King and others, adding that the respondents' point was this—that Mr. Lane-Fox, in describing his system, said that various batteries must be adapted at different points; but in order to do this, he did not show any special means of charging. The learned counsel having dealt with the evidence on this part of the subject, proceeded to the evidence on the effect of attempting to discharge the batteries without switches or with them.

LORD JUSTICE LINDLEY: Your point being, as I understand it, that they won't work without switches.

The learned counsel had not concluded his copious questions from the shorthand notes on the trial dealing with this point when the Court rose for the day.

On Thursday, last week, Mr. WALLACE said he submitted that the evidence he had so far read amounted to this, that taking the admissions of the plaintiff that you must get at least 110 volts, respondents said it required a great deal more, the reservoirs not acting unless they went higher.

Mr. LANE-FOX said he did not admit that.

Mr. WALLACE said he thought that was the effect of the evidence. His next point was that in order to keep the batteries in health you must go to a much higher voltage; and his third, that in order to get the regulated effect Mr. Lane-Fox now alleged, the batteries must be fully charged. The batteries having been invented by M. Planté, any person using them had to take advantage of any inherent defect there might be in the apparatus. The learned counsel accordingly proceeded to read the evidence bearing on these points, during which

LORDS JUSTICES LINDLEY and LOPES incidentally pointed out that what, in effect, Mr. Lane-Fox said was: "I have shown you how to use secondary batteries, and how they may be made to give and regulate a constant pressure." To which respondents said: "Yes; but the benefits which you promise are practically of no use, because the voltage must be of too high a capacity to ensure that benefit."

LORD JUSTICE KAY, calling attention to what appeared to be an inconsistency in some of the evidence bearing on the lamps flickering and yet running all night, even though the dynamos were turned off, Mr. WALLACE said it was explained by the use of switches, turning on extra cells. Batteries could not be used without switches; there was either too much or too small a supply, unless some control was placed over it.

The learned counsel's quotations from the evidence lasted throughout the whole morning, varied only by occasional questions from the Bench by way of explanation (as above) and Mr. Wallace's replies, with occasional interventions to the same end by Mr. Lane-Fox.

As the hour for adjournment arrived, Mr. WALLACE said all their witnesses admitted that the current had to a certain amount the filling up a void.

LORD JUSTICE LINDLEY: But you say it won't work. I suppose it is quite understood that as now improved it would not be so regarded; but it does not follow from this that at the date of Mr. Lane-Fox's invention it was not as he says.

LORD JUSTICE KAY: As I have followed it, this evidence shows that there has been a certain amount of automatical working.

LORD JUSTICE LOPES: And that with it Mr. Lane-Fox shows an amount of inventive faculty. You say that the use of these secondary batteries to produce constant pressure and regulation was known in 1878?

Mr. WALLACE: Yes, I say to a certain extent it was; but I do not want to deal with that part of the case at present. It is said against us that Sir Frederick Bramwell said in certain conditions of the batteries it would tend to a steady light.

LORD JUSTICE LOPES: Which would produce constant pressure and regulation.

Mr. WALLACE: Oh no; only for an instant.

Mr. LANE-FOX: I shall quote a good deal from Sir Frederick Bramwell.

Mr. WALLACE: In that case I had better go through Sir F. Bramwell's evidence—which was accordingly entered upon just as their Lordships retired.

On their Lordships' return they proposed that Mr. Wallace should intimate to them the questions on which his clients relied, and said they would read them from the shorthand writer's notes before giving their decision on the case. To this the learned counsel might now state any additional arguments that he desired to make in support of his case. Mr. Wallace accordingly gave a long list of the questions, and having quoted from yet further evidence on the point of regulation, passed on to the exhibits at the trial, and in the course of explaining them quoted the evidence given against Mr. Lane-Fox's claims. Briefly speaking, the respondents' case was that Mr. Lane-Fox did nothing more than to say that M. Planté had invented a very wonderful thing. Had Mr. Lane-Fox been the inventor of the battery it would have been a very different thing, but he was not. Mr. Lane-Fox referred to certain examples of work he had done, laying stress on the automatic power of the batteries he had set up as an instance of the commercial value of the invention; but the learned counsel went on to quote the evidence of the respondents' against Mr. Lane-Fox's views, and to dispute that his instalments had worked successfully.

Towards the hour for adjournment, LORD JUSTICE LOPES said that Lord Justice Lindley had just suggested that they had not got through half the case yet. Was that true? he asked Mr. Wallace, and that gentleman replied that he hoped it was much better than that.

LORD JUSTICE LINDLEY: Well, perhaps you'll try to finish to-morrow.

On Friday, Mr. WALLACE, for the defendants, continued the reading of the evidence on the trial as to the examples of working of the plaintiff's system, showing that difficulties had been experienced in the designs for the Imperial Opera House at Vienna, and at the King of Roumania's palace, and passing thence to the electric lighting of the Law Courts.

During the latter, LORD JUSTICE LOPES incidentally remarked: Your case has been that the use of the batteries has only a momentary effect; but according to the evidence you are now reading, it would have a tremendous effect.

Mr. WALLACE replied that what they said was that there ought to have been an arrangement for switching in and out; and his point at this moment was what Mr. Crompton, who was connected with the installation, understood of the matter. He had now, the learned counsel added, passed through nearly all the evidence to which he desired to refer.

LORD JUSTICE LINDLEY: Let us have your own view of the case, and Mr. Lane-Fox will then reply.

LORD JUSTICE LOPES: Don't forget that we are going to read all this evidence.

Mr. WALLACE: Not, I suppose, what I am reading.

LORD JUSTICE LOPES: I am not so sure of that.

LORD JUSTICE KAY: I wish you would tell us briefly what you rely on. I think we understand your case generally.

Mr. WALLACE regretted that notes which he had taken of his points at the trial had been mislaid, and this necessarily made his remarks less consecutive than he had designed. Before he went to the specification, he proposed to put in a model used at the trial, showing how the batteries worked, and explained by the evidence of Sir F. Bramwell.

LORD JUSTICE KAY: That will be on the question of infringement.

Mr. WALLACE replied yes, and also on the necessity of having a

number of extra cells, so as to prevent the current, when charging, getting on at high pressure to the main and smashing the lamps.

Their Lordships accordingly inspected the model, and had its arrangements pointed out to them by an expert, Mr. WALLACE reading a written explanation of it, which he handed in, to be used at their Lordships' discretion in looking at the model whilst considering their judgment.

Mr. LANE-FOX asked that the cross-examination of Sir Frederick Bramwell and Dr. Hopkinson should be read on this point, and their Lordships took a note of the question he desired them thus to read.

Mr. WALLACE, thereupon dealing with the specification, said the respondents first of all said there was no novelty whatever in plaintiff's claim, unless there was invention in coupling the batteries to the main. Next, the Attorney-General had admitted the specification did not include the lamps; but

Mr. LANE-FOX said that was not so. He admitted that a special claim for a particular kind of lamp had not been carried out, but he showed that the lamp was an essential part of the whole idea.

LORD JUSTICE LINDLEY said they were not, however, dealing with the lamp now.

Mr. WALLACE then said he would direct his attention to these points—that the distribution was admitted to be old, there was no novelty in the use of secondary batteries, and there was no sufficient direction to enable a workman to work it; Mr. Lane-Fox had, in fact, not described any workable system, and what he did describe was ambiguous. Upon these points he took up a number of passages in the specification and compared them with the evidence bearing on the case, dealing with the regulator, electrometer, and other matters, and submitted that if there was invention in plaintiff's scheme it was not the same as described in the provisional specification. Having next dealt with the claim, he said their Lordships had during this hearing referred to the case of Woodward *v.* Sampson. He in no way disputed that it contained a proper statement of the law, but he pointed out the difference between that case and the present, Mr. Lane-Fox having in the interval between his provisional and complete specification discovered something as an invention which in reality was not an invention.

LORD JUSTICE LINDLEY: After all, it comes back to this, what was the invention?

Mr. WALLACE: It was only a development of the invention; not a new invention, and he also said the provisional specification was bad because of anticipation. He would further simply refer their Lordships to two or three other cases bearing on disconformity, quoted by Mr. Justice A. L. Smith; and he would also ask their Lordships' attention to certain parts of the evidence bearing on the question of the size of the cells; and would simply refer them to the fact, in reference to the disclaimer, that if there was a different invention in 1882 to what was claimed in 1878 then of course it was bad.

LORD JUSTICE LOPES said that he had seen and spoken to Mr. Justice Smith on the point of infringement; and he said he should have held infringement but for disconformity, also because it was not workable, and likewise because if it could be made to work no sufficient information was given.

Mr. WALLACE said that having now dealt with plaintiff's appeal there remained for him to put the grounds of the defendants' cross appeal—that there was no infringement, on the ground "of earth," in the ordinary meaning of the term, and next as to insufficiency—unworkability. The return by the soil of the earth as claimed by plaintiff as essential to his invention, the defendants said was impracticable, and the learned judge held that this was so, but it was not an essential part of Mr. Lane-Fox's invention. On this part of the case an enormous amount of technical evidence was given bearing on the expression "earth" or "the earth." Sir Frederick Bramwell spoke of the heavy expenditure made by the defendants in this connection, and this to a large extent was confirmed by Dr. Hopkinson. If Mr. Lane-Fox would admit that the learned judge's statement was to be taken as correctly stating the fact it would save the reading of a large amount of evidence on the point.

LORD JUSTICE LINDLEY said he supposed it would be admitted that the facts were thus correctly stated, and

Mr. WALLACE then proceeded to quote legal authorities bearing on the point.

LORD JUSTICE LOPES: The earth would have done for a small installation?

Mr. WALLACE: Certainly not for an installation of the extent of Mr. Lane-Fox's

The Court at this stage adjourned.

On Saturday Mr. WALLACE, resuming his arguments, said he was most anxious to finish his part of the case that day. He proposed first to consider the difference between steam and electricity, when

LORD JUSTICE LINDLEY said: I think we understand your point to be that in electricity the return current must be got rid of, in order that the other may be distributed.

Mr. WALLACE consented, and said he would next call attention to certain parts of Mr. Justice Smith's judgment, which he challenged, bearing on the question of the earth, and he handed to their Lordships the questions in the evidence on which he relied in support of that challenge. He next passed on to show that in 1878 secondary batteries were used as reservoirs both for bells and for brakes, thus partially anticipating plaintiff's invention, which too closely approached other inventions to entitle it to the protection asked for. Next, briefly dwelling on the question of infringement, he said their Lordships would perhaps prefer that he should undertake simply to place before them for their future guidance (instead of reading them now) the questions on the evidence on which he relied on this point.

LORD JUSTICE LINDLEY said he thought this in every way preferable.

And generally (added Mr. WALLACE), as the subject had been so technical, if the Court would allow him, he would read a summary of his submissions.

First, as to Mr. Lane-Fox's appeal that defendants had shown (1) that Ayrton's curve breaks lamps at 110 volts, and (2) current at 110 volts must be passed if (*a*) batteries are to store, (*b*) batteries are to regulate flicker, and (*c*) batteries be kept in health. Therefore some method must be adopted either to charge where lamps are disconnected, or with interposed cells and switches, so as to enable normal pressure to be raised without damage to lamps. Neither of these were Mr. Lane-Fox's, but all the systems which have worked use one method or the other. Mr. Lane-Fox's case was not supported by the evidence, and amounted to this—automatic action by having large surface. (*a*) This is a fallacy, for chemical action is the reason for 110 volts if necessary, whatever the capacity of the cells. If surface increased, more current at same pressure required to do the work of storing up the energy. (*b*) Mr. Lane-Fox was thinking of internal resistance of cell, not of chemical work to be done. (*c*) Batteries used by defendants are enormous; Mr. Barrett described them as enormous. (*d*) No sufficiently large battery ever thought of or made. (*e*) Prof. Perry suggested that the same result could be obtained by using a small current with our cells; but all our experiments showed that this could not put in anything in the way of charge. Therefore the patent would not work.

(3) There was disconformity between provisional and complete. (*a*) Use of batteries as reservoirs is not use for flicker regulators. (*b*) Use of batteries as reservoirs is not use for dotting about to get over loss in leads at times of heavy loads; (*c*) use as reservoirs is to add supply, and not to keep constancy; (*d*) the provisional use must at least be good invention, or there can be no development in complete.

4. Disclaimed invention is different from original complete invention.

5. Insufficient description: That the directions given for carrying out the invention are so vague as to be insufficient, in the then state of knowledge; (*a*) plates very large conducting surface, and (*b*) even if switches and extra cells could be read into the specification, no directions how to use such novelties.

Second, as to defendants' cross-appeal:—1. Patent invalid, because with (globe) or gas and water pipes would not work; (*a*) because one method of obtaining light by electricity is the connecting of the negative pole of the lamp with the globe or gas and water pipes. We do not know which way the flow is, and the direction as to return, as it is called, in this, the very first system of electric lighting, is most necessary—witness telegraphy and arc lighting; the only other electrical applications known for these, earth could be used. (*b*) Because earth an essential part of invention and part of merit. (I.) Because of saving in cost of return copper conductor. (II.) Because Mr. Lane-Fox thought the globe was a vast reservoir of electricity, and the current once passed into the earth by an earth plate, and the dynamo connected by an earth plate, the necessary circuit would be formed with no resistance, such as there would be in the case of a return wire. Corroborated by use of batteries dotted about to supply at different points, so as to enable station current to be always same quality, and so prevent variation of loss by resistance, owing to heavy current (*c*) Earth means globe in specification on both views; see books. (*d*) Earth means globe; see evidence. (*e*) Earth would not work; see evidence. (*f*) Would not take current, corrosion of earth plate or pipes, uncommercial size of plate, removal of pipes for repairs, &c., pipes are not continuous conductors—joints, chemical compound covering pipes; resistance of earth plate or pipes will vary in proportion as soil is dry or damp; the pressure absorbed in overcoming resistance will have, therefore, to vary, which will necessitate pressure in mains varying.

It was submitted that it was thus proved patent was invalid, because earth (globe) or gas and water pipes would not work—subject matter (*a*) parallel distribution old; (*b*) batteries old; (*c*) combination old; (*d*) use of batteries as reservoirs with a generating source of supply old; (*e*) use of batteries as reservoirs to take up and provide supply obvious; (*f*) use of batteries for momentary flicker not in patent; (*g*) if it was in patent then it was old.

Plaintiff's object and invention, if any, is to dot batteries about system so that dynamos at central station shall always be generating the same volume of current, whatever the demand the batteries supplying the extra current from each point of the mains, thereby having a fixed amount of pressure only absorbed in overcoming the resistance in leads to the flow of current, and by this means keeping the pressure at each particular point of the mains constant.

Defendants deny infringement, because (*a*) insulated return used by defendants' not earth return; (*b*) use of secondary batteries entirely different.

Whereas the defendants use the batteries simply as reservoirs to supply current from the central station. They rely upon their feeders to keep the current constant for delivery to the lamps all over the system at 100 volts, varying the size and length of their feeders carrying the current from their central station. That is, their feeders, and not their batteries provide for loss through resistance in passing the current through mains.

Plaintiff alleges he uses batteries to regulate. Defendants use them for storage to replace dynamos, their constant of pressure is provided for by mechanical contrivances for regulation of engines.

Perhaps (added Mr. WALLACE, in conclusion), seeing that his arguments had necessarily been less precise, and not so consecutive as he could have wished, their Lordships would not object to take these submissions alongside the notes of the evidence which they were about to consider, the better to enable them to arrive at their decision.

LORD JUSTICE LINDLEY said he thought he spoke the general opinion

of the Court in saying that a synopsis of these arguments on behalf of the respondents as thus offered would be of great service. He did not know that Mr. Wallace had cause for in any way reflecting upon his conduct of the case. It was difficult enough in an ordinary matter to find the notes and memoranda of a trial missing when it came on for argument on appeal; but here the details were so complex, and embodied so large a number of technical details, upon which the Court had had from time to time to ask so many questions, that any seeming shortcomings might very well be excused. With the promise of having the summary of the defendants' submissions handed in at a later period, he would now ask Mr. Lane-Fox to give such an answer as he thought well to what had been said on the other side, simply saying that it seemed to him the Court would like to know exactly the nature of his invention.

Mr. LANE-FOX said he had somewhat anticipated the suggestions of his Lordship. There seemed to him six points, upon each of which he should like to address the Court briefly. The first would be—what was the exact nature of his invention, and its novelty; the second, whether or not it was a subject matter for a patent; the third, its practical utility, and this he had divided under several heads; the fourth, the sufficiency of the specification; the fifth, its disconformity with the provisional; and the sixth, the question of infringement. As to the first question, what the invention was, he took it that he had to deal with the matter in the light of what was understood at the time of his obtaining the patent, and not according as it was now understood.

LORD JUSTICE LINDLEY: Oh yes; of course, as it was; not as it now is.

Mr. LANE-FOX continued that, first dealing with his invention being new, apart from the means of carrying it into practical effect, his aim was from one source of power to distribute the light, so that he could get a variable number of lights and yet have a constant amount of light available at various points of the area or district supplied. To this end he concieved the idea of having force of energy distributed by means of electric currents which might vary in total volume and yet be equally beneficial at any point where it was utilised, or, in other words, a constant potential with a variable load. That was a new idea, and the means by which he had succeeded in putting that idea into effect might be broadly stated as the fundamental basis on which all systems of electric light distribution had since been carried out. The first patent obtained by Mr. Edison for electric lighting dealt with a system of lights and not with one at constant pressure, but he afterwards substituted for that system an adaptation bodily of his (Mr. Lane-Fox's) system, and with it what he admitted was an improvement, relating to incandescent lamps, which would work with his system. The very first of Mr. Edison's patents was applied for three weeks later than his, and it was a little more than a year subsequent to the date of his (Mr. Lane-Fox's) patent that Mr. Edison took out a protection for his improved carbon filament lamp. It had been generally admitted that this was constructed largely on the lines described in his (Mr. Lane-Fox's) patent, namely, a lamp to work in a system of distribution at constant pressure, which had a high resistance and was made with a small luminous surface, proportional to the amount of light it was intended to give, and temperature as high as possible to the material used for the purpose of incandescence. This being broadly his idea of having a variable supply at a constant pressure he endeavoured to find out a means whereby it was to be put into practical operation. One of the influences which seemed to him to be most important to this end was that he should not have to rely solely upon the generator and steam engine, but that he should, at the same time, have a reserve which would act at the time as a sort of buffer or spring, to take in or give out current according to variations of pressure. Planté's batteries, which he proposed to use for this purpose, were very well known; otherwise he should have thought it important to describe them more fully, and he adopted them as in the nature of this spring or buffer. Without desiring to be egotistical as to the effect of his discovery, but for the purpose to which he was now challenged, he referred their Lordships to the evidence of Professors Barrett, Silvanus Thompson, Perry, and others, describing his specification as an absolute revelation, and one of the most wonderful for originality in scientific history—everything, of course, depending, as he had before said, upon the state of knowledge at that period, and on the aims at which those connected with the development of electric lighting were directing their efforts at that date. It was even then well known that you could divide an electric current into any number of parts according to a fixed law—that the current was often compared to a stream of water, which could be divided and subdivided; and this was what he stated in his evidence before the learned judge hearing the case. But the idea that you could have what is spoken of as a pressure in a conducting main always tending to develop current at a constant electromotive force in any and every direction, wherever it might be required, was an entirely new idea, and the means for carrying it into effect, he submitted, was a patentable subject matter, however simple those means might be.

In answer to an observation by Lord Justice Kay, Mr. LANE-FOX said you could not get any current anywhere without difference of pressure, but the ordinary notion of a current was derived from having a battery of high resistance giving off a quantity of fixed current and utilising it at different points with comparatively low resistances, and it was common to speak of batteries giving a constant quantity of current. The difference between current and pressure, Mr. Lane-Fox added, in reply to a question by Lord Justice Lopes, was, that a current was the vehicle of energy, and the pressure that which determined the strength with which it was made to flow through a resistance offered to its passage. Passing on to the question of earth, Mr. Lane-Fox added that the difficulty of getting a good earth was very well known; and, dealing with the arguments of the other side on this subject, he said their Lordships, in the passing observations they had made on his submissions, rightly interpreted his case to be that the soil would ordinarily be a sufficient conductor for installations up to a limited scale, but if the installations were large, some better conductor must be used. Then, coming to the question of utility, he compared, as overwhelming, his own evidence with that of the defendants, and had arrived at the consideration of the case as regarded the batteries when the Saturday afternoon's adjournment was reached.

On Monday, Mr. LANE-FOX said, when the Court rose on Saturday, he was concluding his remarks about the action of secondary batteries, and their practical utility. He should like to recapitulate some of the points he endeavoured to make as dealing with the pith of the matter, apart from the question of switches, which he proposed to deal with presently. Defendants had been at great pains to prove that whatever was the size of the battery, there must be considerable difference in the voltage between the empty and full battery. They also proved in a most elaborate way that you could force a large current through a small battery, and get a considerable difference in the voltage between discharge and charge. He never disputed this. Batteries might be discharged with considerable potential differences, which were due to the strength of the current relative to the conducting surface; and on this point his own evidence was strongly in favour of what the defendants took much pains to prove. Not only was the fact well known, but M. Planté had explained it in his writings, prior to the date of his (Mr. Lane-Fox's) patent. Another point was this, that what might be a large current for a certain size battery, might be very small for another sized battery; but you might have a large or small current compared with a certain sized installation, and this might or might not be large or small, relatively to the battery used. He thought he also proved that within certain limits of plate area of a battery, you could charge and discharge with a very small potential difference. It was admitted that some current would come in and out of the battery with a small potential difference. Consequently, unless you were hampered with considerations as to the full storage capacity in your cell, you could charge and discharge within very narrow limits of pressure. His witnesses showed that the simple question of taking the batteries was rather larger than those sometimes used. In opposition to the evidence of Sir Frederick Bramwell, that he did not think the company could pay a good dividend if they had the plate cell area spoken of by Prof. Perry, Mr. Lane-Fox gave some technical details showing that it would not be necessary to have the batteries spoken of by Sir F. Bramwell, but that they could be spread over a larger area, and so get a larger conducting surface, and then, having referred to the question of voltage as bearing on the question of regulation, he said that the defendants had been good enough to send him a copy of the summary they had handed to their Lordships, and upon this he should like to make some remarks; but

LORD JUSTICE LOPES said why not give the Court a similar statement of Mr. Lane-Fox's summary of his arguments?

Mr. LANE-FOX said he should be very pleased to do this, and proceeded to deal with some of the more glaring of the defendants' arguments, adding that he was prepared, both in the Court below and here, to give additional evidence if it was thought necessary; but

LORD JUSTICE LINDLEY said he thought Mr. Lane-Fox would do better not to critically examine the summary. The Court would have, after all, to see how far it was borne out by the evidence.

Mr. LANE-FOX said he had no fear in relation to it; all he wanted to show was that it could be answered.

Eventually it was decided that Mr. Lane-Fox should send to their Lordships a detailed summary of his statements; and the appellant concluded by expressing his obligations to their Lordships for their great patience in listening to his argument.

Mr. WALLACE proposed to say a few words with reference to the cross-appeal; but

LORD JUSTICE LINDLEY thought they had already heard all that could be fairly said on the case.

With this the proceedings ended, LORD JUSTICE LINDLEY telling Mr. Lane-Fox that the formulation of their judgment would take some little time.

A Manufacturing Electrician in the London Bankruptcy Court.—At the London Bankruptcy Court last Tuesday, the first meeting of creditors was held before Mr. E. L. Hough, O.R., under the failure of Walter Philip O'Reilly, manufacturing electrician, 397, Edgware Road, lately carrying on business at 397 and 399, Edgware Road, and 124, Old Broad Street, City. The debtor who filed his own petition on the 18th June, has prepared accounts showing gross liabilities £2,744 17s. 4d., of which £2,294 17s. 4d. are expected to rank; assets valued at £33 15s. 8d., and a deficiency of £2,261 1s. 8d. A lengthy statement respecting the debtor's present position was made. After some further discussion the meeting was adjourned for three weeks.

NEW PATENTS—1892.

11,487. "An apparatus for erecting top and middle sections of telephones and other poles." R. F. JEFFRIES. Dated June 20th.

11,525. "Apparatus for use in manufacturing electric cables." G. G. M. HARDINGHAM. (Communicated by Felten and Guilleaume, Germany). Dated June 20th.

11,526. "Improvements in electric cables." G. G. M. HARDINGHAM. (Communicated from Felten and Guilleaume, Germany). Dated June 20th.

11,528. "Improvements in dynamo-electric machines and motors." J. A. C. ZIEGLER, W. R. RUTLEDGE, and F. E. ALLAN. Dated June 20th.

11,532. "Improvements in secondary or storage batteries." W. A. BOESE. Dated June 20th.

11,548. "Improvements in connection with lubricators used on dynamo-electric and similar machinery." C. S. SNELL and WOODHOUSE AND RAWSON UNITED, LIMITED. Dated June 21st.

11,556. "The magnet trap." R. C. MEEKREN. Dated June 21st.

11,592. "Means for operating ammeters and other electrical apparatus." C. K. MILLS. (Communicated by H. M. Pilkington and R. S. White, United States.) Dated June 21st.

11,617. "Improvements in or relating to dynamc-machines." C. J. HALL. Dated June 21st.

11,624. "Improvements in coin operated telephone apparatus." H. H. LAKE. (Communicated by E. Noriega, Mexico). Dated June 21st.

11,634. "Improvements in or relating to electric railways." F. WYNNE. Dated June 21st.

11,640. "Improvements in electric meters." F. H. NALDER, H. NALDER, C. W. S. CRAWLEY, and A. SOAMES. Dated June 21st.

11,664. "Improvements connected with tubular electric conductors and their insulation." E. PAYNE. Dated June 22nd.

11,672. "Improvements in armatures for alternate current dynamo-electric machines and motors." R. E. B. CROMPTON, and S. L. BRUNTON. Dated June 22nd.

11,683. "Apparatus for separating magnetic ore from sand." W. B. BASSET. Dated June 22nd.

11,692. "Improvements in electric locomotives." F. PURDON, H. E. WALTERS, B. MOTT, and J. P. O'DONNELL. Dated June 22nd. (*Complete.*)

11,698. "Improvements in insulators for overhead and other electric wires." F. MEYER. Dated June 22nd. (*Complete.*)

11,702. "Improved means for effecting automatic translation on long telegraphic circuits." E. RAYMOND-BARKER. Dated June 22nd.

11,735. "Improvements in and connected with electric dynamo machines distribution by means of transformers, organs, and the reduction of zinc." J. SWINBURNE. Dated June 23rd.

11,779. "Improvements in the manufacture of carbons for electric arc lamps." G. F. REDFERN. (Communicated by C. Braun, Germany.) Dated June 23rd. (*Complete.*)

11,807. "Improvements in and relating to the measuring of electricity, and in meters therefor." R. KENNEDY. Dated June 24th.

11,817. "Improvements in the means for distributing theatrophonic and other like auditions." B. MARINOVITCH and G. SZARVADY. Dated June 24th.

11,822. "Improved means for electrically winding up the weight for driving clockwork and other mechanism." H. ARON. Dated June 24th.

11,823. "Improvements in apparatus for measuring electric currents." H. ARON. Dated June 24th.

11,835. "Improvements in the process and apparatus for tanning hides and skins with electrolytic action." E. J. FINOT. Dated June 24th.

11,849. "Improvements in distribution and branch boxes for electric circuits." S. BERGMANN. Dated June 25th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

The Price of all Specifications (old and new) is now 8d. each.

1,069. "Improvements in globe and shade holders for gas, electric light, and oil lamps, chandeliers, and other similar articles." J. BROOKES and E. G. WARD. Dated January 21st. The object of this invention is to provide a holder having three or more arms, which are so made as to dispense entirely with a gripping screw or screws, or the lever fastening actions which are at present used in holders of this kind. 2 claims.

9,683. "Improvements in electric primary batteries." T. J. D. RAWLINS and A. WALKER. Dated June 8th. Consists in forming the electrodes of disc shape, and attaching them on an axle arranged to be revolved. 1 claim.

10,977. "Improvements in galvanic batteries." A. DE MERITENS. (Under International Convention.) Dated November 28th, 1890. A galvanic cell or element arranged according to this invention is constructed with a plate of zinc, combined with a couple formed by an electrode or plate of lead, soldered or connected to a plate or electrode of aluminium, or other acid proof material, such as platinum or carbon for example, and immersed in a diluted solution of sulphuric and nitric acids in water, preferably in the proportion of about two parts of sulphuric acid to one of nitric acid. 6 claims.

11,075. "Electric meters." B. J. B. MILLS. (A communication from H. M. Pilkington, and R. S. White, both of New York.) Dated June 30th. Relates to mechanically registering electric meters wherein an electrically operating device determines the application of a source of motion to the register in accordance with variations in the electric current being measured, and the object is to produce an apparatus of this general character which will be accurate and efficient in use and not liable to get out of order. 5 claims.

12,046. "Improvements in or relating to electric motors." J. SAHULKA. Dated July 15th. Mainly consists of four magnets or systems of magnets between the poles of which are placed two armatures; each of the opposite pairs of magnets having one of the alternate currents flowing round it and the armature being magnetised periodically along two diameters. 3 claims.

13,070. "Improvements in or relating to the construction and erection of telegraph or similar posts, and in appliances for use in connection therewith." G. C. DYMOND. (A communication from abroad by C. Bourdon, of Paris). Dated August 1st. Bars of rolled iron or steel of any suitable section are used which are selected according to the number of wires that the posts must carry. They are then cut to a suitable length, and after having been completely dressed, a sort of point is formed at one of their extremities having the same angle as that of the crowbar which was used to form the holes. This point is intended to fill the lower part of the hole and to establish between the posts and the earth a contact, thereby preserving the line from the effects of being struck by lightning. As soon as the bar assumes its ordinary section, it is fitted into the sheath to which such a height is given that its upper part, when the posts are erected, rises above the soil, say to between 10 and 20 centimetres. 2 claims.

14,295. "Apparatus for protecting electric installations for telegraphic, telephonic, and lighting purposes from the effects of lightning or discharges of atmospheric electricity." G. W. SPITTLE. Dated August 24th. Claim:—Apparatus for protecting electric installations from discharges of atmospheric electricity, consisting of the combination of an electro-magnet connected with the line wire, a pivoted armature, in conducting connection, with the electro-magnet, a screw contact connected with the instrument or machine to be protected, and a second screw contact connected with earth, the said parts being so arranged, that under normal working the armature is removed from the electro-magnet and makes contact with the screw for completing the circuit of the instrument or machine, but when a discharge of atmospheric electricity takes place, this, in passing through the electro-magnet, causes it to attract the armature, which is thereby made to break the circuit of the instrument and to make contact with the earth screw, substantially as described.

14,768. "Improvements in lightning arresters." W. P. THOMPSON. (A communication from abroad by J. P. Freeman, of America.) Dated September 1st. In this arrester a series of independent fusible wires of platinum or similar material is employed, which are brought one after another into use as a part of the normal or working circuit. These wires are mounted on a rotary or other movable support, actuated by a spring, so that when one wire is burned out, severing connection with the instrument and opening the circuit, the rotation of the support will bring the next wire into position to re-establish the circuit. With this rotary carrier are combined ground connections, so that after the fusing of one wire has released the carrier, and before the latter has turned sufficiently to introduce the next wire into the circuit, the ground connection will be established. In the ground line an electro-magnet is located which acts through intermediate parts to maintain the ground connection and to prevent the introduction of the next fusible wire into the circuit until the abnormal current has ceased.

CORRESPONDENCE.

Switches.

In the letter of Mr. F. J. Walker, in last week's number, under the heading of "Gas *versus* Electricity," he mentions that the "Tumler" and most other switches, by being moved slowly, can be made to arc.

Allow me to point out that this defect is entirely absent in the switch lately designed and patented by me, the "Unique," which is illustrated in the same number.

A. P. Lundberg.
P. A. L.

July 5th, 1892.

The Tramways Institute.

On page 17 of your last issue, I am reported to have said that I "considered the average efficiency of a storage battery to be not more than 33 per cent." What I did state in connection with the discussion of Mr. Epstein's paper at the Tramways Institute was, that in practical everyday work with storage battery cars, the *total* efficiency, viz., the ratio between the indicated horse-power at the charging station, and the power given off at the car axles, did not exceed 33 per cent., and that this result was nearly as good as with the best methods of electric traction worked with either overhead or underground conductors.

A. Reckenzaun.

July 5th, 1892.